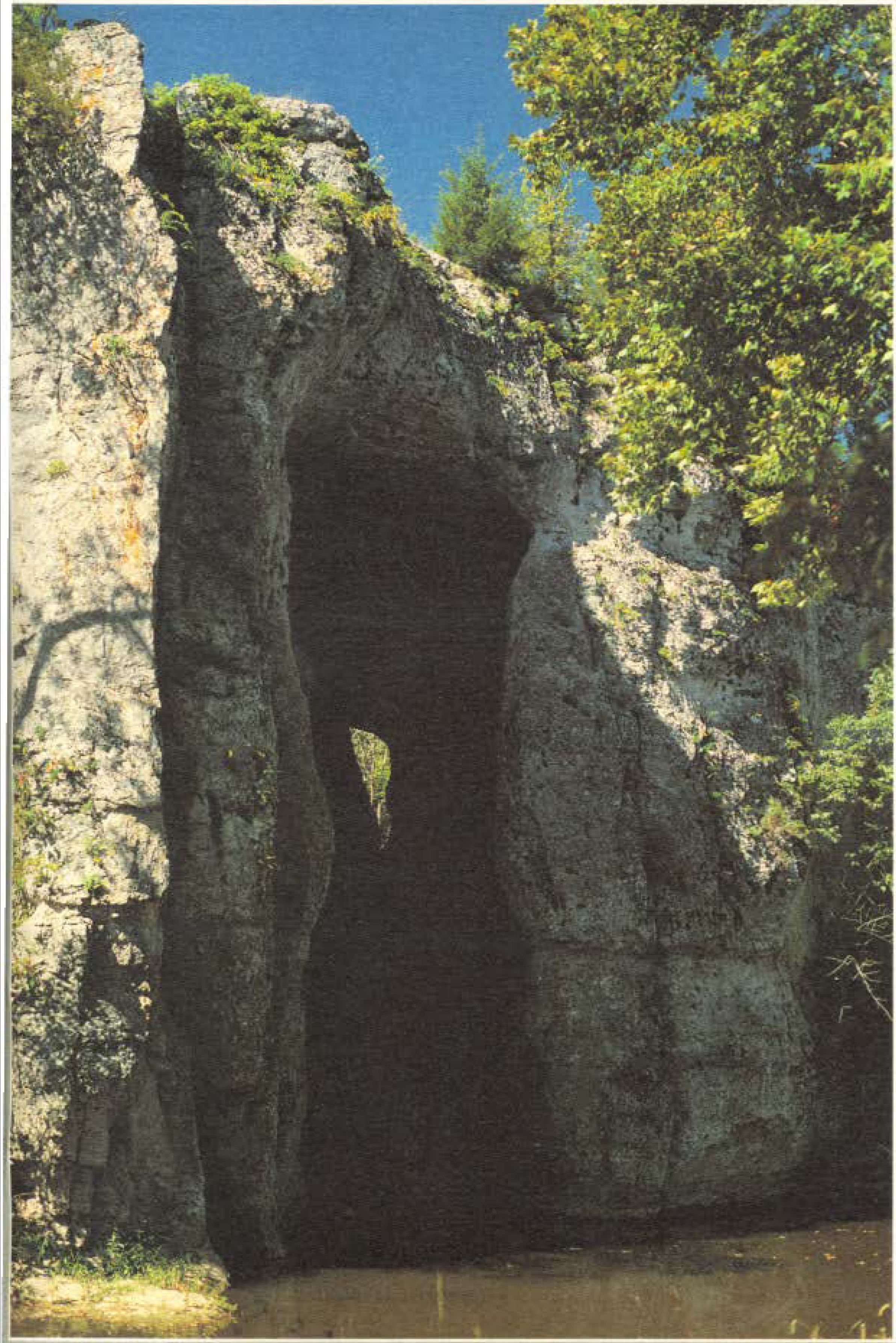
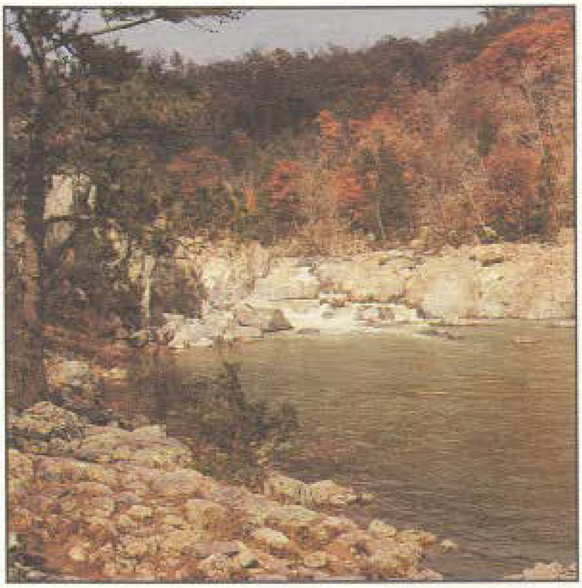


GEOLOGIC WONDERS AND CURIOSITIES OF MISSOURI



Johnson Shut-Ins

Educational Series No. 4
Revised 1990

GEOLOGIC WONDERS AND CURIOSITIES OF MISSOURI

by
Thomas R. Beveridge

Second edition revised by
Jerry D. Vineyard
Deputy State Geologist

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND LAND SURVEY
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Front cover: Sandy Creek Natural Tunnel

Back cover: The Sinks Natural Tunnel

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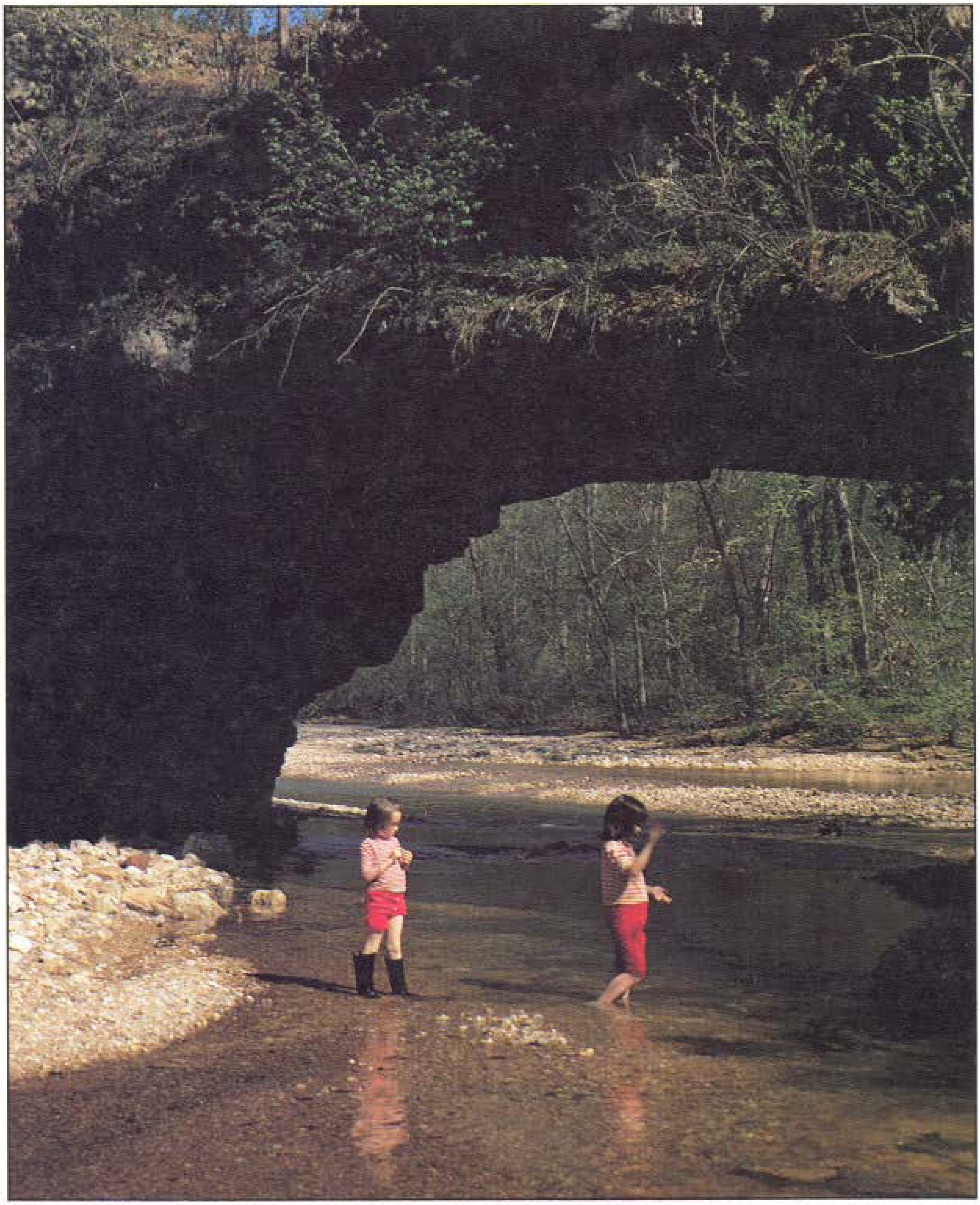
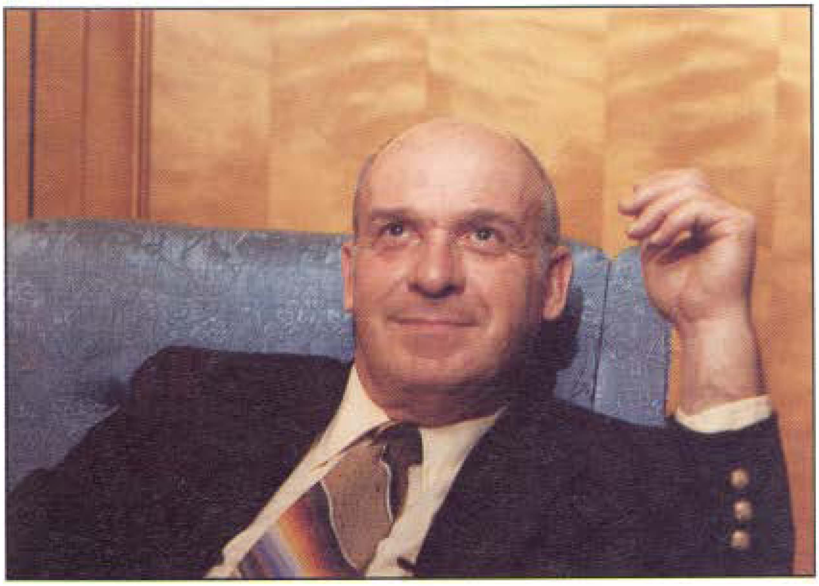


Clifty Natural Bridge. Photo by Jerry D. Vineyard.

About
The Author



THOMAS R. BEVERIDGE

Someone said of Thomas R. Beveridge that he was "a character with character" . . . And so he was. His quick wit and expressions were unique and this book — an effort covering more than a decade — is "pure Beveridge."

State Geologist of Missouri from 1955 through 1964, Tom Beveridge was noted for his wit and charm as well as for his considerable accomplishments in an astonishing range of activities. He was State Geologist during one of the most exciting times in Missouri geology — the decade of exploration that led to discovery and development of the Viburnum Trend, now the world's most productive lead mining district.

Following his tenure as State Geologist, Dr. Beveridge (Tom to just about everybody) joined the faculty of the University of Missouri-Rolla where he enjoyed a career as a professor who consistently won awards for teaching excellence from the student body.

A "transplanted Presbyterian" from Illinois, Tom Beveridge made Missouri his home and developed a benevolent interest in the history, folklore, habits, and language of Missourians, particularly the people of the Ozark hill country.

Tom's fascination with and respect for Missouri people illuminates his writing with gentle and subtle wit. A favorite pastime for Beveridge, and the source of much of the information on geologic sites in this book, was attending country auctions. Here he met the people on their turf, where he obviously enjoyed their company, and they, his.

Over the years he developed an outstanding collection of Ozark "antiques" — furniture, tools, collectables of all kinds — with which he and his wife Nan furnished their comfortable home on "Pea Ridge," where they had an inspiring view of Tom's beloved Ozarks.

Geologic Wonders and Curiosities of Missouri was a labor of love — for the geology that only another geologist could appreciate, and genuine respect and admiration for the "home folks" who are stewards of these things.

For many years, the Beveridge calendar was crowded with speaking engagements to every imaginable group with whom he shared his enthusiasm for Missouri. Thousands saw and heard previews of this book through Tom's illustrated lectures, punctuated by the Beveridge humor and laced with pungent observations about religion (or lack of it) as practiced denominationally. Tom's after-dinner talks at conventions sent many an out-of-state visitor back home with pleasant Missouri memories.

So read these pages with a light heart; look for the "Beveridgisms" that make scholarly science a pleasure to read. Enjoy the book, and better still, visit and wonder about, as the author did, the places that help make Missouri unique among states.

Tom Beveridge amassed information on more than 400 interesting places in Missouri, and Jerry D. Vineyard added many others, but there surely are some that have escaped attention; any reader who knows of a site not covered herein is invited to communicate through the Missouri Department of Natural Resources, Division of Geology and Land Survey at Rolla.

Jerry D. Vineyard
Deputy State Geologist

This revised edition contains many minor changes, including directions for reaching some features, ownership, new and/or additional information about sites, and other miscellaneous improvements. Jerry D. Vineyard added numerous new sites that came to his attention after publication of the First Edition. Those feature descriptions written entirely by him are noted by the initials JDV after the feature name.

1918-1978

Dr. Thomas R. Beveridge died on August 24, 1978 in his home in Rolla, Missouri after a long struggle against cancer. He was 60 years old. Beveridge grew up on a farm near where he was born in Sandwich, Illinois in 1918. There he is buried. His wife, Nan, was killed in a school bus accident in 1982. He is survived by two daughters.

The photo of Dr. Beveridge on page v was taken by his brother-in-law Franklin Newhall.

Foreword

Missouri is an amazingly varied landscape that reflects the character of the underlying bedrock. In the same way that the weather-beaten visage of a farmer reflects the seasons of drought, flood, cold, and heat, so the face of Missouri reflects the ages of time. The land has been shaped by geologic forces as mighty as continental drift, and as gentle as ground water dissolving limestone, or wind depositing dusty layers of loess.

Compared to the human life span, geologic changes seem infinitely slow. Yet, during the course of the geologic history of Missouri, many unusual features — wonders and curiosities, to be specific — have developed. The writers of this book have found and described many of these oddities, some of which, while they required countless years to develop, have been obliterated by human activity. Fortunately, most are still relatively the same, changeless yet changing ever so slowly.

From the once-molten, igneous rock knobs of the St. Francois Mountains, to the gentle mounds and glacial erratics of northern Missouri, our state is a fascinating land. In so many instances, unusual geology and equally unusual human history combine to produce places of extraordinary interest. Graham Cave, in Graham Cave State Park, for example, is a geological marvel that also harbors a history of human habitation dating back over 8,000 years.

Many of the wonders and curiosities described and pictured in these pages are in state parks or on other public lands. Others are privately owned but shared with visitors in the tradition of Missouri hospitality. In the rugged Ozarks region of our state, large areas of public lands are linked by trail systems that cross state parks, state forests, and federal lands. The Departments of Natural Resources and Conservation have established a Missouri Natural Areas System, that already includes many of the geologic sites described in this book, set aside for the enjoyment and wonder of generations to come.

As you read these accounts of Missouri's geology, from the pen of one of our most memorable State Geologists, remember that the stewardship of these and all other natural resources is the responsibility of all Missourians. As Dr. Beveridge might have said, "Walk softly and carry a camera!"

G. Tracy Mehan III, Director
Missouri Department of Natural Resources

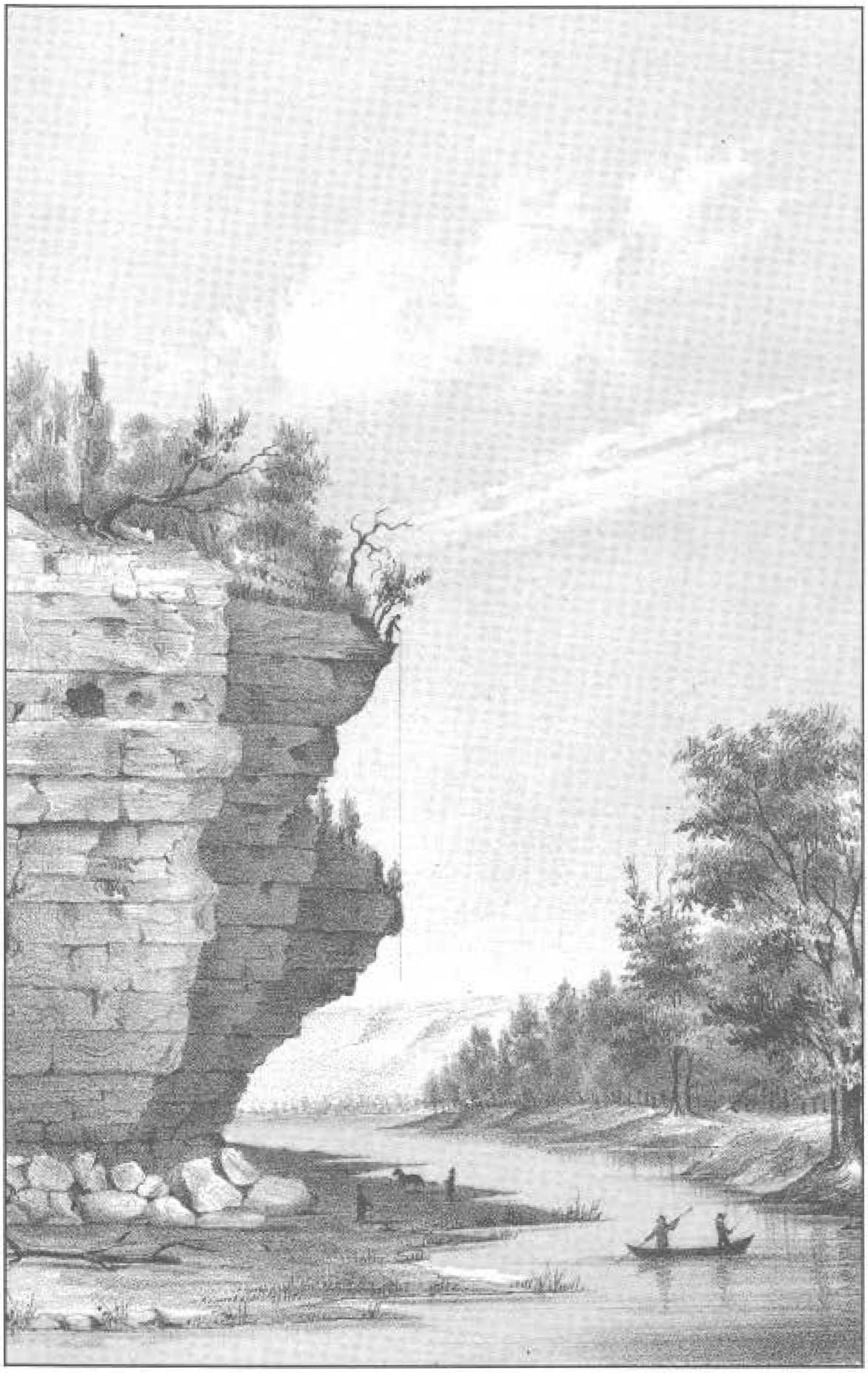


Figure 1

Missouri's natural attractions are a result of geologic processes that shaped the landscape. This view of a bluff on Gravois Creek in Morgan County is from Broadhead, 1873.

1

Introduction

"Were the Elephant Rocks brought by a glacier? Why is Natural Bridge Road in St. Louis so named? What is a shut-in?" Such commonly asked questions as well as inquiries regarding locations and origins of other unusual geologic features provided the nudge for this publication. Its inception dates back to a card file of Missouri's natural bridges started in the 1950's; this file grew to include other geologic features of possible interest to the layman, and is still growing at publication time.

Missouri has great geologic variety and has long been a world-famous mining state. Recreation, although a more recent industry, is a major one and many of the natural recreational attractions which have given Missouri the motto, "wake up to Missouri!" are a direct result of the geologic processes which have shaped the landscape (fig. 1). The Missouri Geological Survey (now Missouri Department of Natural Resources, Division of Geology and Land Survey) has published reports on the caves (Bretz, 1956) and springs (Beckman and Hinchey, 1944; Vineyard and Feder, 1974) of Missouri and receives many inquiries relative to geologic features other than caves and springs. This report is an attempt to answer such inquiries and to describe a host of both well-known and little publicized scenic and/or intriguing geologic attractions. To minimize repetition, the features are categorized primarily by form or origin. Sites are described in numerical order and are located geographically on plate 1. The appendix describes how to use topographic maps to locate features.

It is understood that cataloging will be enlarged as additional sites or areas are submitted; any supplementary information will be appreciated. The compilation may seem provincial because the Ozarks are especially well endowed with geologic attractions and are in the backyard of the Division of Geology and Land Survey. Any slighting of other areas in Missouri is not intentional.

ACKNOWLEDGMENTS FOR THE FIRST EDITION

The Board of Curators, University of Missouri, granted Dr. Beveridge a sabbatical leave for the spring of 1972 which made this report possible.

Staff members of the Missouri Department of Natural Resources, Division of Geology and Land Survey have given much assistance in calling attention to unusual features and special acknowledgment is due to James Martin, Charles Robertson, and Jerry D. Vineyard for such contributions. Mr. Vineyard contributed a large amount of information on sites, gave freely of his time for conferences, took most of the photographs, and wrote descriptions of several locales. C. Helmer Turner of Springfield, retired Missouri State Highway Department geologist, provided many data on features in southwestern Missouri.

William C. Hayes, former State Geologist, has long had an interest in this compilation and the writer is grateful to him and his successor, Wallace B. Howe, for their support and constructive criticism.

Others with the Missouri Department of Natural Resources, Division of Geology and Land Survey who provided assistance include Barbara Harris, editor, who was responsible for final editing, layout design, and publication while staff geologist Arthur W. Hebrank served as technical editor. Copy was typeset by Barbara Miller and illustrations were prepared by Gary Clark, Susan C. Dunn, Billy G. Ross, and Randal Rinehart.

George C. Schowengerdt of the University of Missouri-Rolla (UMR) faculty gave assistance on locales in the Irondale area and students at UMR, especially John Baz-Dresch, David Butherus, and Anita Williams, supplied information on nearly a dozen natural bridges. Mr. Eugene Degenhardt of the U.S. Army Corps of Engineers, St. Louis District, furnished data on the Mississippi River channel and Grand Chain. Albert J. Krueger of the Missouri State Highway Department assisted with information regarding central Missouri sites. Special thanks are due Richard Gentile of University of Missouri-Kansas City (UMKC) and Harry King, formerly of Southern Missouri State University (SMSU), for descriptions of sites 108, 287, and 370, respectively.

Of the many citizens who cooperated with information and hospitality, the following were especially helpful and merit acknowledgment for their contributions: C.E. Boulson and Allen Conrad of the Sho-Me Power Corporation, Marshfield; Perry Bryan of Round Spring; Gordon Collett of Kirksville; the late J.J. Connelly of Ironton; George Crighton of Springfield; Ray Doerhoff of St. Elizabeth; George F. Hellmuth of St. Louis; Elmo Ingenthron of Kirbyville; George Kastler of Lebanon; William Royce of Doniphan; Elmer Tiemann of Fredericktown; and Cleo Yancey of Steelville. Mrs. Bruce Rau and Mrs. Kenneth Myers of the UMR Graduate School Research Office expedited completion of the manuscript by retyping the first draft. Mrs. Charles Deloach of the School of Engineering also transcribed dictation and retyped first drafts.

The late Professor J.B. Butler of the Missouri School of Mines and Metallurgy was a pioneer in compilation of county maps (now out-of-print) showing unusual natural features of the Ozarks and his work was both an inspiration and a foundation for the present work. The Missouri Department of Natural Resources, Division of Geology and Land Survey reports, *Springs of Missouri* (Vineyard and Feder, 1974) and *Caves of Missouri* (Bretz, 1956) make numerous references to geologic features of interest associated with spring and cave systems.

The idea for this report on unusual geologic features dates back to a card file on natural bridges started in the 1950's. . . . .

ACKNOWLEDGMENTS FOR THE SECOND EDITION

This edition of Thomas R. Beveridge's *Geologic Wonders and Curiosities of Missouri* contains many new entries and improved information on features previously described. Jerry D. Vineyard, who wrote parts of the first edition, contributed many illustrations, and collaborated with Dr. Beveridge in publishing the book, compiled the information for the second edition. Mr. Vineyard is Deputy State Geologist of Missouri. Like Dr. Beveridge, he has maintained a career-long interest in unusual geologic features of Missouri. As Dr. Beveridge did, he frequently gives illustrated lectures on Missouri's natural features and is ever on the lookout to add more sites to the nearly 500 features recorded in this book.

As with the first edition, numerous citizens contributed information and illustrations to make the book more complete. Members of the Missouri Speleological Survey, Inc., documented several natural arches and tunnels in their work of compiling information on Missouri caves. Mr. Scott House was especially helpful. Other members of the Survey are acknowledged with the text associated with their contribution. Mr. Don Kurz of the Missouri Department of Conservation sent information on several sites. Mr. Gary Reese provided a photo of "The Pinnacles" in Boone County. Mr. Dickson Stauffer, formerly a staff artist with the Department of Natural Resources, provided several pen-and-ink drawings. Mr. Walter Solovik graciously guided the author to "The Candlesticks," one of the most noteworthy of the features in this edition. James E. Vandike and Arthur W. Hebrank of the Geological Survey Program, Missouri Department of Natural Resources, Division of Geology and Land Survey, contributed information on several sites. Vandike also provided several of the new illustrations.

Staff of the Geological Survey Program produced the revised manuscript and illustrations — Keith Wedge, chief of Information Services Section; Gary Clark, graphics supervisor; Phillip Streamer, Susan C. Dunn, and Billy G. Ross, graphics specialists; Betty Harris, typesetter; Sharon Krause, typist; Robert H. Hansman, editor.

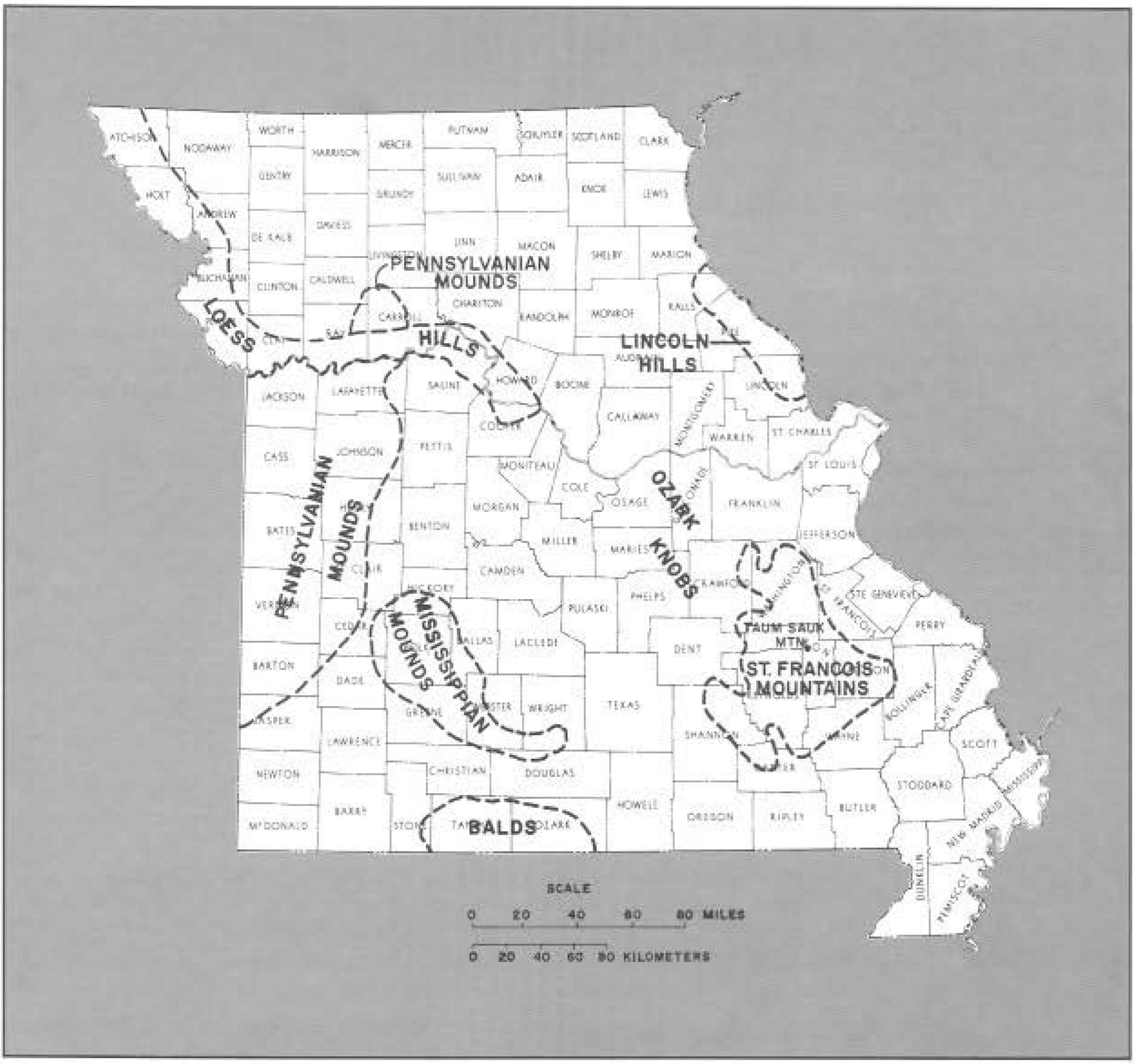

PENNSYLVANIAN MOUNDS
LOESS HILLS
LINCOLN HILLS
PENNSYLVANIAN MOUNDS
MISSISSIPPIAN MOUNDS
OZARK KNOBS
TAUM SAUK MTN.
ST. FRANCOIS MOUNTAINS
BALDS
SCALE
0 20 40 60 80 MILES
0 20 40 60 80 KILOMETERS
ATCHISON
NODAWAY
WORTH
HARRISON
MERCER
PUTNAM
SCHUYLER
SCOTLAND
CLARK
HOLT
GENTRY
GRUNDY
SULLIVAN
ADAIR
KNOX
LEWIS
ANDREW
DE KALB
DAVIESS
LINN
MACON
SHELBY
MARION
BUCHANAN
CLINTON
CALDWELL
LIVINGSTON
CHARITON
CARROLL
RANDOLPH
MONROE
RALLS
PIKE
CLAY
RAY
AUDRAIN
LINCOLN
JACKSON
LAFAYETTE
SALINE
HOWARD
BOONE
CALLAWAY
MONTGOMERY
WARREN
ST CHARLES
CASS
JOHNSON
PETTIS
COOPER
MONITEAU
COLE
OSAGE
GASCONADE
FRANKLIN
ST LOUIS
BATES
HENRY
BENTON
MORGAN
MILLER
MARIES
JEFFERSON
ST CLAIR
HICKORY
CAMDEN
PHELPS
CRAWFORD
WASHINGTON
ST FRANCOIS
STE GENEVIEVE
VERNON
CEDAR
POLK
DALLAS
LACLEDE
PULASKI
DENT
IRON
PERRY
BARTON
DADE
GREENE
WEBSTER
WRIGHT
TEXAS
REYNOLDS
MADISON
BOLLINGER
CAPE GIRARDEAU
JASPER
LAWRENCE
SHANNON
WAYNE
SCOTT
NEWTON
CHRISTIAN
DOUGLAS
CARTER
STODDARD
MISSISSIPPI
McDONALD
BARRY
STONE
TANEY
OZARK
HOWELL
OREGON
RIPLEY
BUTLER
NEW MADRID
DUNKLIN
PEMISCOT

Figure 2

Hill-mountain types and terminology.

2

Mountains, Hills, Knobs, and Mounds

The geologist, with his passion for terminology, has wisely (or resignedly) abstained from defining the difference between a *knob, hill,* and *mountain.* The cliché regarding visitors in Rome is applicable to Missouri place names for heights; if the local residents call a 100-foot-high bump a "mountain," a mountain it is! Figure 2 shows the generalized distribution of hill-mountain types and terminology.

The naming of heights does have a general, although not consistent, geographic trend in Missouri. *Knobs* are the most common names in the Lincoln Hills of northeastern Missouri in Lincoln, Pike, and Ralls Counties, although an exception is The Pinnacle at Clarksville. In general, there is a tendency to call the rugged areas of Jefferson and Ste. Genevieve Counties *hills,* whereas the exceptionally high areas in the vicinity of Ironton and Potosi are appropriately called *mountains.* The term *mounds* is most common in the relatively flat areas of western Missouri south, east, and northeast of Kansas City and *balds* are most common in Ozark, Douglas, and Taney Counties in southwestern Missouri. The term "Pilot Knob" is rather common in the Ozarks and Moses would have been busy had he visited all the Mt. Pisgahs and Mt. Nebos in the state. Probably the origin of the term Pilot Knob dates to the usage of such promontories for early land navigation (pilotage).

In general, individual hills were not pushed up into their present positions by some geologic force, but exist as a result of erosion which left them behind as remnants of a formerly extensive upland surface. Definite exceptions to this are the loess hills of northwestern Missouri formed by deposition of windblown silt and clay and, possibly, the hills and mountains of the St. Francois Mountains-Potosi-Eminence area, which were formed by the erosion of sediments of a massive uplift of once-molten igneous rocks in the far distant geologic past.

The Lincoln Hills owe their existence primarily to the erosion of an anticline, the Lincoln fold, an arch trending northwest from Lincoln County through Ralls County. The hills of Jefferson and Ste. Genevieve Counties resulted from the erosion of an escarpment of northeast- to east-dipping rocks. The Benton Hills of southeastern Missouri, south of Cape Girardeau, are erosional remnants or "lost hills" as discussed in the section on the Southeastern Missouri Lowlands.

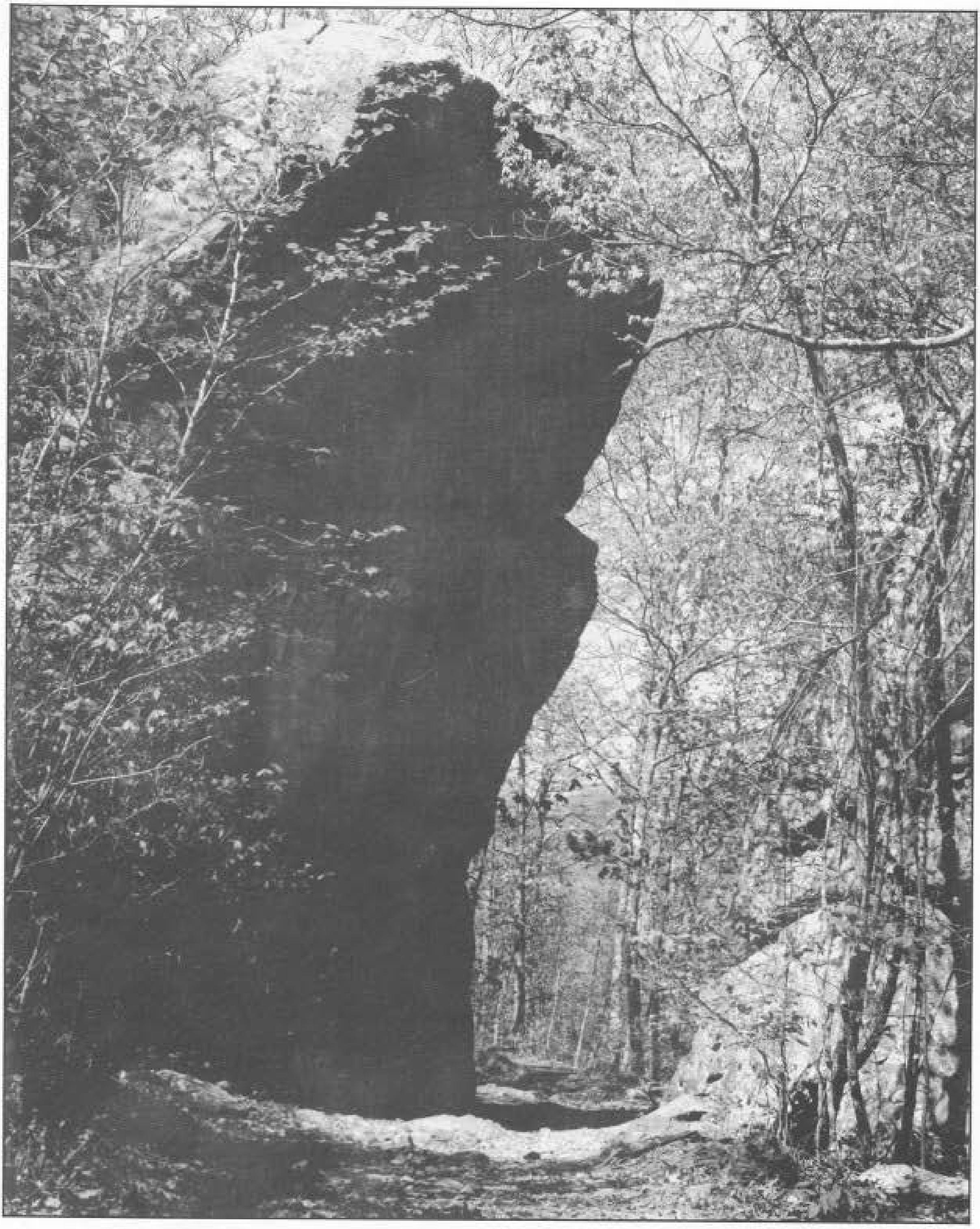


Figure 3

One of several interesting features near Taum Sauk Mountain is Devils Toll Gate. Photo by Jerry D. Vineyard.

TAUM SAUK MOUNTAIN AND RELATED AREAS

Iron County, at terminus of Highway CC, 4 miles (crowline) southwest of Ironton, in secs. 4, 5, 7, 8, and 9, T. 33 N., R. 3 E., Ironton 7½-minute Quadrangle. (See No. 2, Lead Hill, and No. 3, Seymour Ridge, for their locations.)

An outsider attempting to describe the many unusual and scenic geologic features of the Ironton-Arcadia Valley area feels frustrated in realizing that he could do the area justice only were he to live there for many months and explore the mountains, shut-ins, and many other features on foot. The Taum Sauk Trail, which extends from the Elephant Rocks south to Shepherd Mountain Lake, thence southwestward over Taum Sauk Mountain to Johnson Shut-Ins State Park, is an excellent hiking route for getting both the intangible and tangible feel of the St. Francois Mountains area. The Graniteville, Ironton, and Johnson Shut-Ins 7½-minute Quadrangles are modern and invaluable aids for following the trail. A visit to Taum Sauk Mountain and several of its nearby features (fig. 3) is greatly enhanced by having the Ironton 7½-minute Quadrangle in hand.

1. TAUM SAUK MOUNTAIN

Taum Sauk Mountain, with an elevation of 1,772 feet above sea level at its crest in the SW¼ SE¼ sec. 4, T. 33 N., R. 3 E., is the highest point in the state.

This mountain is composed mainly of porphyry with a few exposures of granite. Both of these once-molten rocks are Precambrian and thus over a billion years old, belonging to rocks assigned to the oldest geologic era. The Precambrian rocks are deeply buried beneath younger sedimentary rocks outside of the Ozark area, being at the following approximate depths (in feet) beneath the surface in other areas of Missouri: St. Louis, 4,000; Hayti, 5,000; Kansas City, 2,400; Columbia, 2,000; Rolla and Jefferson City, 1,800; Joplin, 1,700; and the northern part of Missouri, 2,000 to 4,000.

2. LEAD HILL

Taum Sauk is offered stiff competition by two other exceptionally high areas in Webster and Wright Counties. Lead Hill, 2 miles east of Cedar Gap or 4 miles west of Mansfield between the Burlington-Northern Railroad track and Highway 60, rises to 1,744 feet above sea level. It is slightly south of the center of sec. 24, T. 28 N., R. 16 W., and is named on the Cedar Gap 7½-minute Quadrangle.

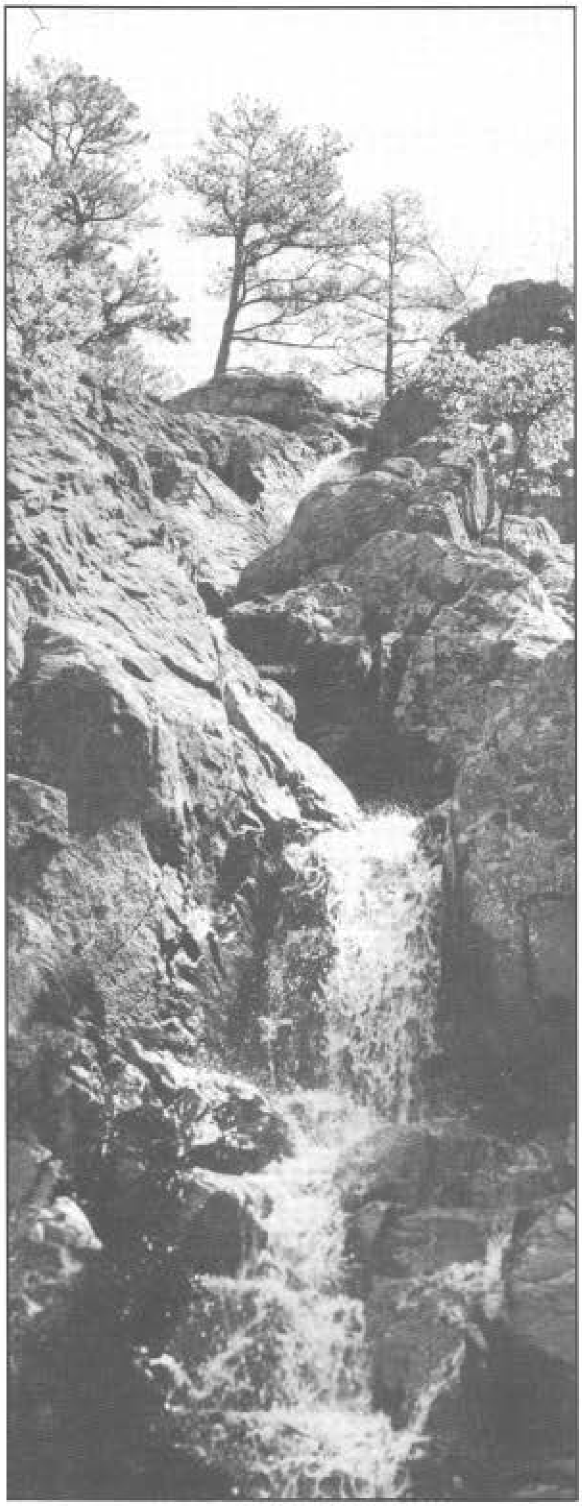


Figure 4

Mina Sauk Falls. Photo by Jerry D. Vineyard.

3. SEYMOUR RIDGE

Not many miles away from Lead Hill (No. 2), a rather inconspicuous ridge (7 miles northeast of Seymour) has an elevation of between 1,740 and 1,760 feet above sea level. The exact elevation of the crest is not indicated on the Mansfield NW 7½-minute Quadrangle map. This ridge is slightly east of the center of the south line of sec. 1, T. 29 N., R. 17 W. Much of the upland area along Highway 60 near and north of Seymour is more than 1,600 feet above sea level but the elevation is not conspicuous because of the gently rolling nature of the country.

4. MINA SAUK FALLS

The Taum Sauk Trail passes a short distance south of Mina Sauk Falls (fig. 4), a mile southwest of the crest of Taum Sauk Mountain. The falls is also called Evangeline Falls because it is allegedly referred to in Longfellow's poem of that name. This site, in the SW¼ NE¼ NW¼ sec. 8, T. 33 N., R. 3 E., holds honors as the highest waterfall in Missouri with a fall of 132 feet in cascades, the main cascade representing a drop of nearly 105 feet. Water does not flow the year around and the waterfall enthusiast should time his visit to avoid dry periods. According to the legend of Mina Sauk (the daughter of Chief Taum Sauk), a spring in the mountain which contributes to the flow of the falls was formed by a bolt of lightning sent by the Storm King. The chief of a hostile tribe who had made love to Mina Sauk was captured and killed and, according to the legend:

> *"...the young captive was thrown from ledge to ledge, being caught on the points of up-lifted spears. His grief-stricken bride, calling a curse down on her tribe, leaped from the highest ledge and was dashed to death beside the body of her slain lover. The Great Spirit invoked the Storm King, causing a cyclone to utterly destroy the people of Ton* [sic] *Sauk. A bolt of lightning striking the mountain top caused the stream of water to flow over the ledges into the gorge below, to wipe away the blood of the young lovers. On the banks of the stream sprang up flowers of crimson hue, which grow there*

today, by the overflowing water and which are known as Indian Pinks." (Stevens, 1921, p. 556).

The statement regarding the overflowing water is a bit charitable and cannot be depended on for all seasons. The jagged rock in the falls is a pink porphyry with major vertical fractures parallel to the face of the nearly vertical falls; secondary fractures are parallel to the valley.

5. DEVILS TOLL GATE

Three-quarters of a mile farther down the trail, southwest from the falls, is the Devils Toll Gate (fig. 5), also shown on the topographic map. The Toll Gate is an 8-foot-wide gap in a ridge of orange to red porphyry which is 50 feet long and 30 feet high. The gap is probably a vertical fracture system enlarged by weathering. The road passing through this gate is a historic old military road leading to the Southwest Territory and, according to some, is also a portion of the infamous "Trail of Tears" followed by the Cherokee Indians in their forced migration of 1838-39. The Devils Toll Gate was aptly named because the Devil collected his toll by forcing the unloading of long wagon trains and swinging them around by hand for penetration of the narrow passage.

Stevens (1921, p. 556) has preserved the Piankisha tribe legend of the Toll Gate as follows:

"Long years ago, before the coming of the Piankishas, a maiden of a tribe living in the Valley of Flowers became lost in the Tom Suck [sic] *wilds. A monster of gigantic size and ferocious aspect accosted her, and as escape was cut off by the granite wall her capture seemed certain until the Great Spirit, with a bolt of lightning rent the granite wall, affording her opportunity to escape."*

From the parking area atop Taum Sauk Mountain, the following route leads to Mina Sauk Falls and Devils Toll Gate: Follow the Taum Sauk Trail as shown on the Ironton 7½-minute Quadrangle in a southwesterly direction to a small spring on the right side of the trail. This spring has been partly circled by rocks and is in a semicleared area where the slope is gentle. A brisk walk to this spring took almost 50 minutes. A few feet beyond the spring, a faint trail branches to the right (northwest) and descends a steep slope to the upper part of the main falls, about 250 yards from the spring. The path continues down a steep slope along the south rim of the canyon with a spur into the canyon terminating a short distance downstream from the falls. The canyon rim trail is the one shown on the topographic map.

About a quarter of a mile southwest of the falls, the trail joins the present-day main trail which leads to Devils Toll Gate. The return walk from Devils Toll Gate bypasses the falls trail by taking a more direct route to the south. This new stretch of trail is not shown on the Ironton 7½-minute Quadrangle.

The falls are difficult to photograph; a wide-angle lens, a minimum of foliage, and afternoon timing being desirable. The Toll Gate is easily photographed at about any time of day in any season.

Mina Sauk Falls, Devils Toll Gate, and Taum Sauk Mountain are included in a 3,250-acre tract recently acquired by the Department of Natural Resources, to be added to 2,490-acre Johnson's Shut-Ins State Park, thereby more than doubling its size. State Park management is expected to result in an improved and expanded trail system and an interpretive program.

RESPECT OTHERS:
Ask permission to visit
private property

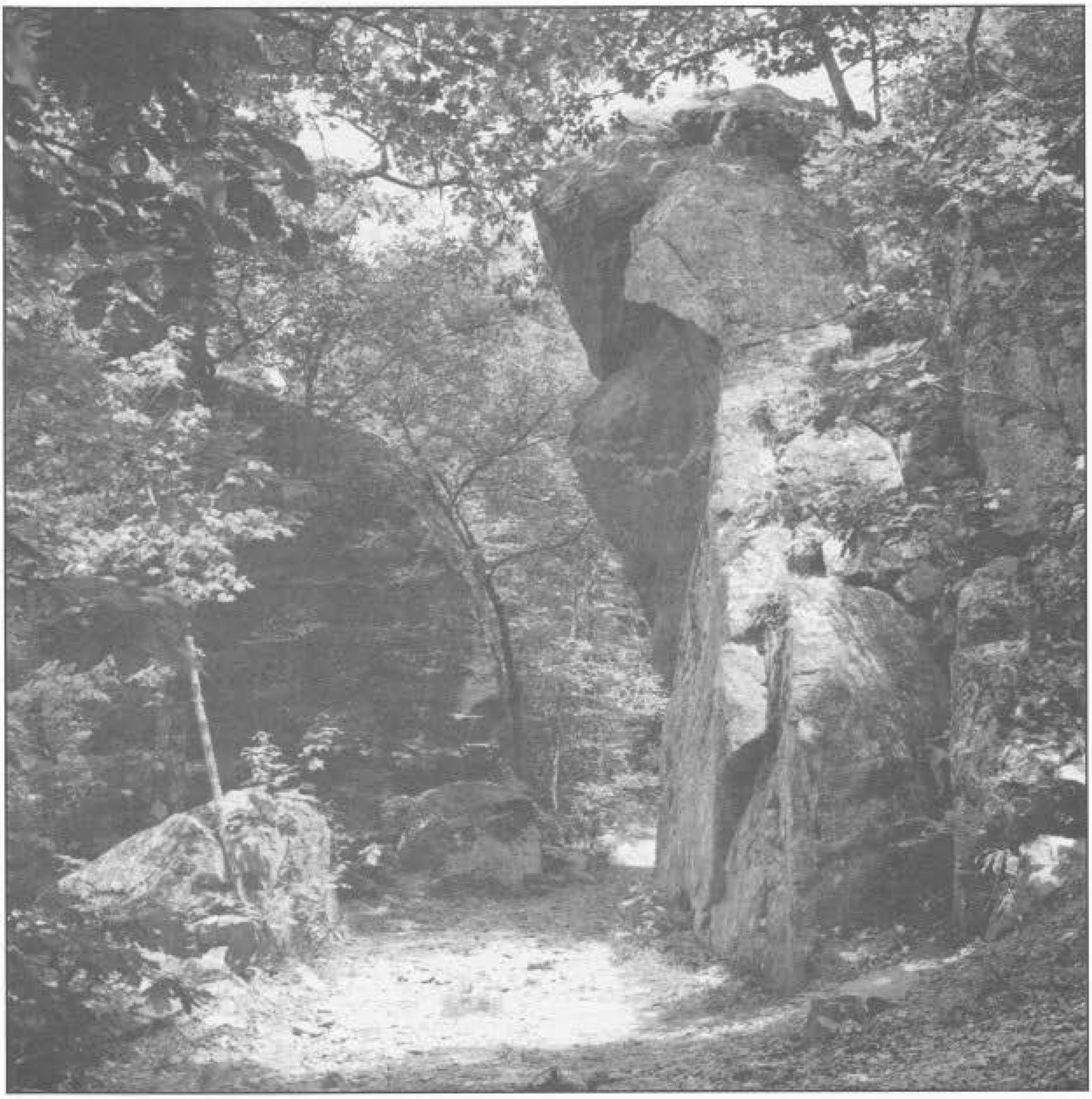


Figure 5

Devils Toll Gate. Photo by David Hoffman.

ST. FRANCOIS MOUNTAINS AREA

6. DEVILS WALL

Iron County, 1.5 miles west of Taum Sauk Mountain crest, on southwest edge of Wildcat Mountain, in SW¼ SE¼ sec. 6, T. 33 N., R. 3 E., Johnson Shut-Ins 7½-minute Quadrangle.

Charles Robertson supplied information on this feature which has been anonymous, probably because of its isolated location in very rugged terrain. The name is coined herein on the assumption that the keeper of the Devils Toll Gate, 1 mile to the southeast, would consider Wildcat Mountain a perfect home.

The Wall consists of a jagged wall and columns of jointed rhyolite (actually an ignimbrite or fused volcanic ash to the purist) which form a partly ruined wall on the southwest edge of Wildcat Mountain not far below the crest. The view from the site is reportedly, as also suggested by the topographic map, one of wild ruggedness with a minimum of man-made scenic pollution.

As shown by the topographic maps, the hiker could reach this area via the Taum Sauk Trail, leaving it near Mina Sauk Falls or by walking south for approximately 3.5 miles from Highway H at the west line of sec. 31, T. 34 N., R. 3 E.

7. TAUM SAUK HYDROELECTRIC PLANT

Reynolds County, on Proffit Mountain and East Fork Black River, 6 miles north of Lesterville, in secs. 15 and 21, T. 33 N., R. 2 E., Johnson Shut-Ins 7½-minute Quadrangle.

Union Electric's Taum Sauk pumped storage hydroelectric plant is not at its namesake mountain but rather at Proffit Mountain, 5 miles southwest of Taum Sauk Mountain. Despite the fact that the operation is not a natural feature, a description is appropriate because the site would appeal to those with a yen for geology, engineering, or scenery. The top of the mountain has been levelled off and ringed by a dam to produce one of the few mountaintop reservoirs in the world.

From this reservoir, a 7,000-foot shaft and tunnel lead to a powerhouse containing reversible pump-turbine units and thence to a lower reservoir in East Fork Black River. When electrical power demands are low, as at night and on weekends, electric motors furnish the power to pump waters from the lower reservoir to the upper one. When the energy demand is high, water from the upper reservoir flows to the lower reservoir and the turbines operate the electric motors converted into generators to produce power.

The crest of the mountain is composed of once-molten rhyolite-porphyry and the core in part of granite porphyry. Those interested in the more serious aspects of geology should obtain permission to view the contact of these Precambrian igneous rocks with the overlying Bonneterre Formation at the power plant. The general public should not fail to visit the excellent museum near the reception center en route to the upper reservoir. This museum, which includes exhibits in geology and a variety of natural sciences, is adjacent to a picnic area.

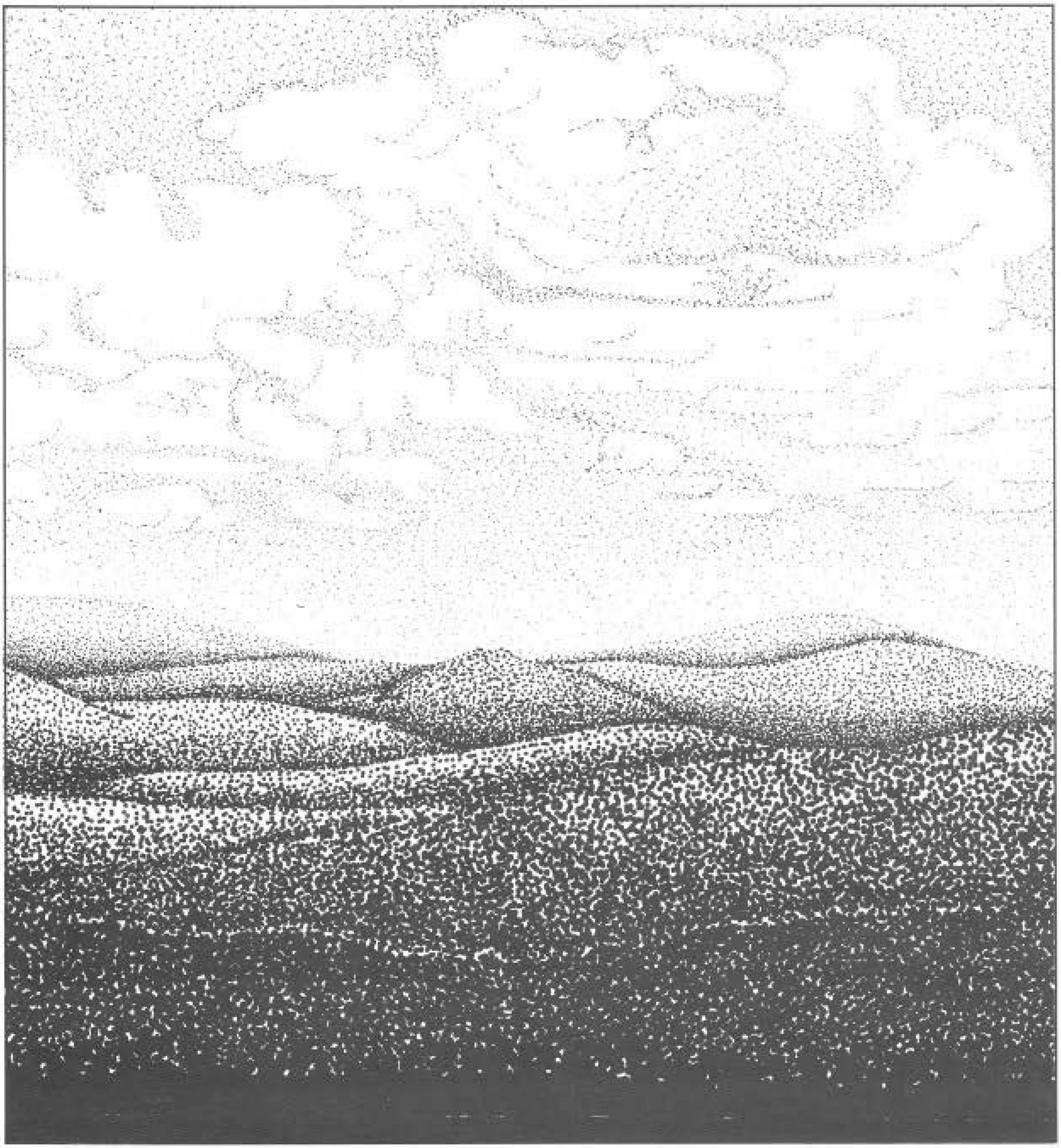


Figure 6

St. Francois Mountains near Ironton, Missouri. Drawing by Susan C. Dunn.

The installation may be reached by two routes: Turn west off Highways 21 and 72 onto Highway AA at Hogan, 7 miles south of Arcadia, and follow AA and a marked road westward for about 8 miles, or, turn off Highways 21, 49, and 72 north onto Highway U, slightly over a mile east of Lesterville.

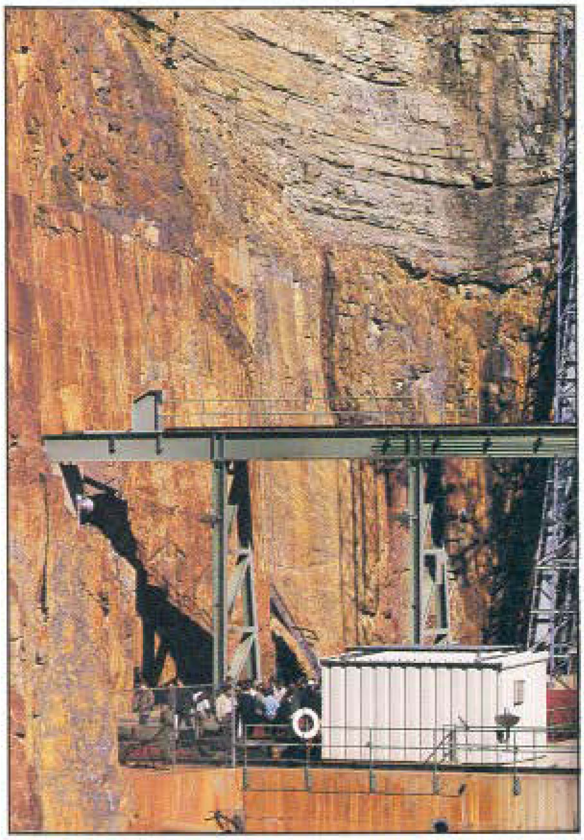


Figure 7

The contrast between billion-year-old igneous rocks and the much younger sedimentary rocks that lie upon them is nowhere more striking than at Taum Sauk Power Plant. The massive reddish-brown igneous rocks have a vertical orientation, with the gray layered sedimentary rock piled on the uneven contact with the igneous mass.

8. CATHEDRAL CANYON (JDV)

Madison County, 3 miles north of French Mills, off Highway E, in Mark Twain National Forest, in secs. 33 and 34, T. 33 N., R. 5 E., at the common corners of the Lake Killarney, Rhodes Mountain, Rock Pile Mountain, and Des Arc NE 7½-minute Quadrangles.

Topographic maps show this feature as Dark Hollow, but hikers and backpackers who visit the place reverently call it Cathedral Canyon. It is one of the best places in Missouri to see the special ruggedness of the St. Francois Mountains.

Cathedral Canyon (Dark Hollow) is the steep-walled valley of Lower Rock Creek, a small stream that has eroded its way through tough Precambrian igneous rocks. The 1,400+-foot summit of Trackler Mountain lies to the north, and to the south, Black Mountain rises to 1,502 feet. The elevation at the mouth of Lower Rock Creek is about 580 feet; at the "Cathedral" section of the valley the elevation is about 760 feet. The gradient of Lower Rock Creek from the Cathedral to the mouth is about 100 feet per mile, which makes a visually exciting and generally noisy stream. The streambed, pink and purple rhyolite for much of its course, tumbles over rock ledges and around boulders.

A hike up Lower Rock Creek is a journey into the dim and violent past. The rocks through which the little creek has carved its valley are rhyolites and, in the upper reaches, ignimbrites. These are technical terms for volcanic rocks, which date from a period when active volcanoes erupted lava and ash that covered the region with volcanic extrusives that still preserve flow structure and other lava-field and ash-fall characteristics. For a description of the volcanic history of the St. Francois Mountains, the interested reader should consult Kisvarsanyi (1976) and Kisvarsanyi et al. (1981).

Cathedral Canyon is partly on private land and partly in National Forest ownership. Reaching the Cathedral itself, which is a 400-foot high rock wall at a sharp bend in the creek about midway up the valley, requires hiking at least 2 miles in, plus the return trip. Topographic maps show a jeep trail that approaches the Trackler Mountain summit, which is much closer to the best part of the canyon; however, taking the motorized way means missing the fascinating structure and colorful scenery of the lower valley.

No one should venture into the canyon without a topographic map, because frequent stopping to study the map gives much better insight into the topography details, and allows one to rest while appearing very scholarly. Unfortunately, the area covers the common corners of four topographic maps, which are very inconvenient to manage, especially on a windy day, and somewhat expensive as well. A Forest Service map is also helpful, because it shows ownership and is more easily managed. The trail, simply developed from people visiting the area, was not designed and laid out according to a plan.

There are two basic routes into Cathedral Canyon (fig. 8). The first option is to park at a private home along Highway E, near where the highway crosses Lower Rock Creek. Be certain to ask permission; the landowner may charge a parking fee. Hike up the creek for approximately 2 miles to the Cathedral, where there is a bit of relatively flat ground and evidence of campfires. According to Todd (1978), there are "... two shafts of granite [sic]" about 350 feet up the Cathedral which have been called the "reigning masters of this beautiful wilderness." Reigning masters they may be, but they are not granite; they are rhyolite, an extrusive (volcanic) igneous rock, as opposed to granite, an intrusive (magmatic) rock.

The second option is to follow a gravel road leading off Highway E, about in the center of sec. 35. Park near the northeastern corner of sec. 34. Follow logging roads and trails up over a saddle and down into Lower Rock Creek. From there, follow the trail to the Cathedral. Should one feel up to more hiking, the topographic maps show other trails at the headwaters of Lower Rock Creek, leading toward Kelley Mountain and up Barren Hollow.

The Lower Rock Creek area can be reached from Fredericktown, by driving west on Highway E, approximately 10 miles to the St. Francis River, then 0.3 mile farther to the road into Wolf Hollow, or 0.8 mile to the mouth of Dark Hollow.

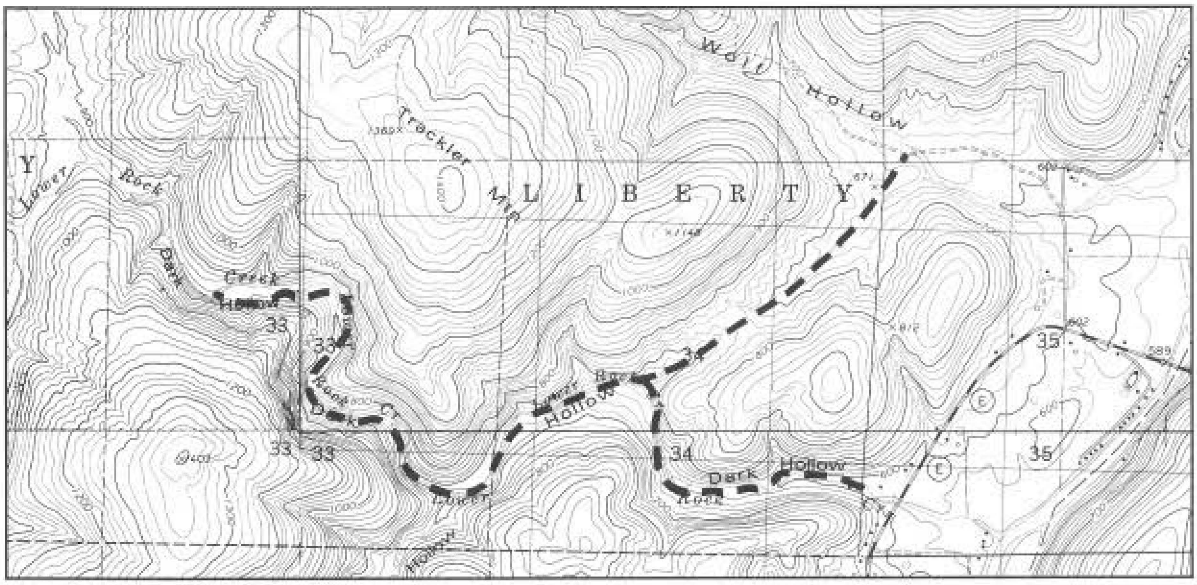


Figure 8

Parts of the Lake Killarney, Des Arc NE, Rhodes Mountain, and Rock Pile Mountain Quadrangles join to produce a map of the Cathedral Canyon (Dark Hollow) area. Hikers may approach the "Cathedral" area by alternate routes shown by dashed lines.

9. THE ELEPHANT ROCKS

Iron County, at northwest edge of Graniteville, in E½ NE¼ sec. 15 and W½ W½ NW¼ sec. 14, T. 34 N., R. 3 E., Graniteville 7½-minute Quadrangle.

A large herd of elephants in Iron County, Missouri, has provided a 12-month hunting season for those who cannot afford the more expensive safaris. But, in addition to having endured thousands of years of exposure to the elements, this ancient herd has survived decades of those hunters who, armed with chisels and hammers, have been bent on perpetuating their memories (and romances) in the thick hides of the herd via the common American custom of initial carving.

When last sighted, this herd, commonly known as the "Elephant Rocks," (fig. 9) was resting a short distance south of Highway 21 at the northwest edge of Graniteville in Iron County.

Since no naturalist or wildlife conservationist has made an official census of the herd, the exact number of elephants inhabiting the grounds is uncertain. However, some specific information has been gathered concerning Dumbo, the pink granite patriarch of Elephant Rocks, who lies atop the granite ridge to the northeast of the parking area. Dumbo is approximately 27 feet tall, 35 feet long, and 17 feet wide. On the basis of a weight of 162 pounds per cubic foot, this ponderous paleopachyderm is estimated to weigh about 680 tons, making him easily the heaviest elephant on any continent. The next boulder to the northeast of Dumbo is the Balancing Rock, safe, thanks to the laws of inertia, from concerted attempts at toppling.

In conjecturing about the geological birth of the herd, many adults (perhaps subconsciously influenced by the myth of the stork) think that the elephants were "brought by the glacier." This hypothesis can be discarded because glaciers, like (or unlike) storks, didn't get into the Ozarks; the southern limit of glaciation in Missouri is approximately Interstate Highway 70, or a beeline between St. Louis and Kansas City.

Elephant Rocks is, in fact, a *tor,* a prominent residual mass of bedrock exposed and formed by selective weathering and subsequent removal of the weathered materials. The name (probably cognate with Gaelic *torr:* heap, pile) was originally applied to such features in Great Britain, most notably in Devonshire, on the Dartmoor granite massif.

Approximately 1.2 billion years ago — give or take a few million — molten rock was intruded into the area from below. This molten material cooled to become granite and, as it cooled, nearly vertical cracks (joints) developed. These joints were further developed by strains created in the uplift which produced the Ozarks. Two major systems of joints resulted, the most marked trending slightly north of east and the other northwest. Jointing of the granite produced huge oblong blocks subsequently laid bare by erosion and modified by weathering which rounded off the corners and produced the elephants (fig. 10). Granite typically weathers to rounded shapes as freeze-thaw action and chemical reactions cause the granite to spall and crumble. The efficiency of freeze-thaw weathering is demonstrated by the shallow birdbath basins on the granite aerie reserved for Dumbo and his favorite wives. These basins were probably shallow depressions in which water could accumulate and were deepened by spalling as the water alternately froze and thawed and by chemical reactions between the water and mineral crystals in the granite.

GEOLOGIC FEATURES
TAKE MILLIONS OF YEARS TO
DEVELOP; WE HAVEN'T TIME
TO MAKE NEW ONES....

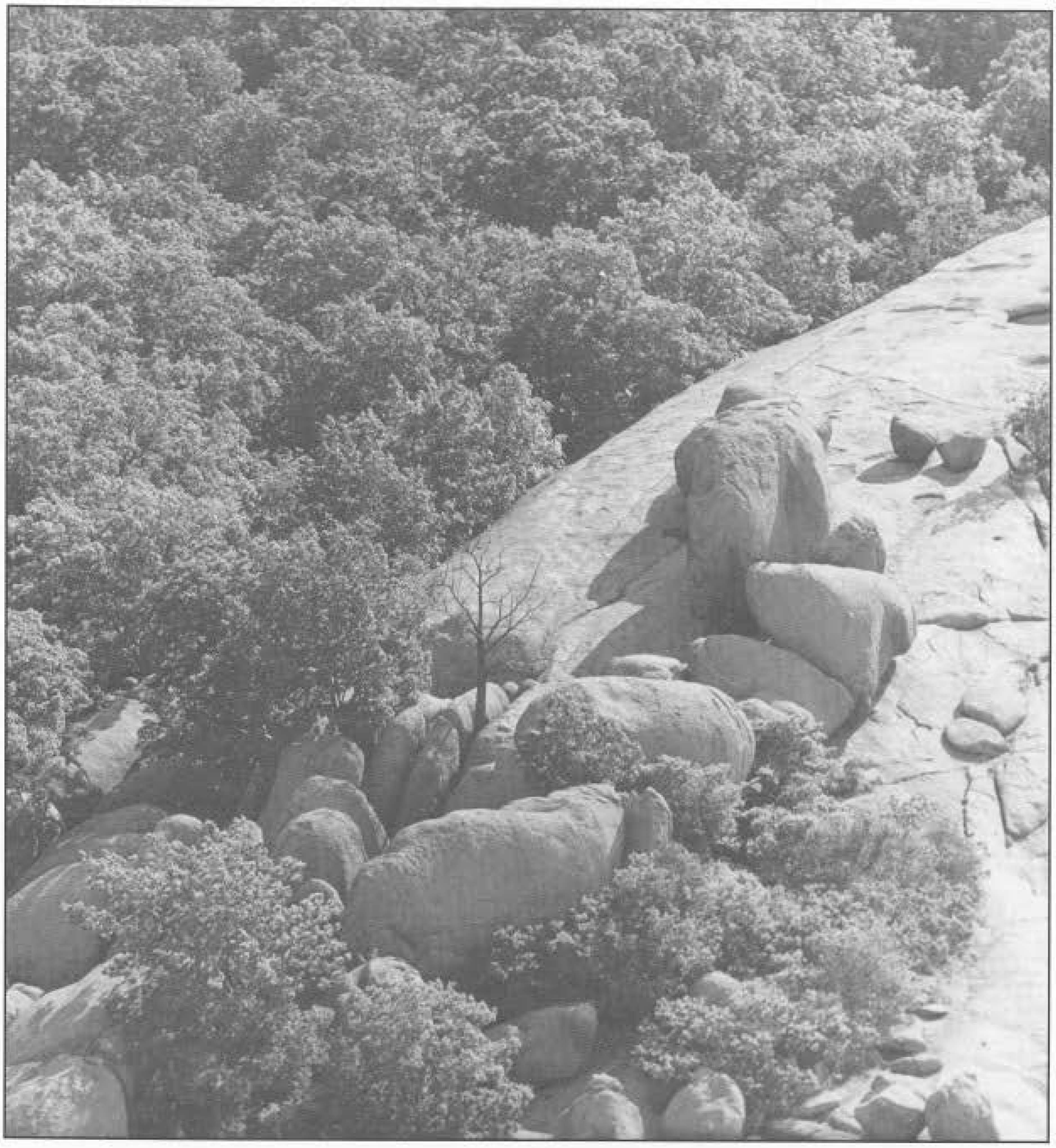


Figure 9

This ancient herd — The Elephant Rocks — may be found in Iron County. Photo by Jerry D. Vineyard and David Hoffman.

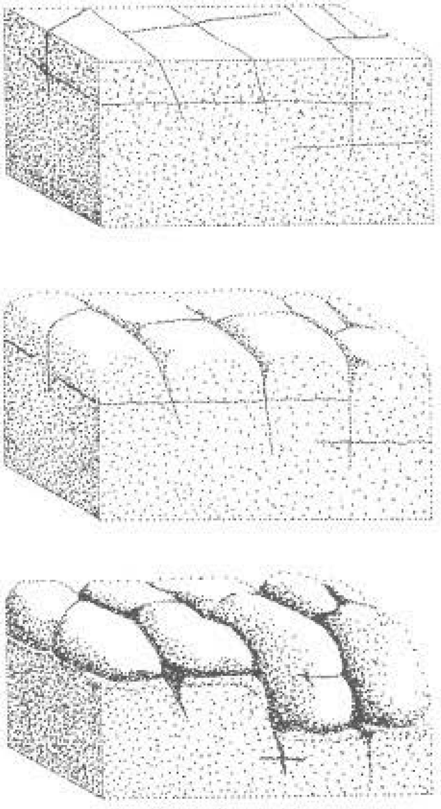


Figure 10

Probable stages in the development of the Elephant Rocks.

In addition to producing the overall shape of Dumbo, vertical joints cutting across his body have been enlarged by weathering to produce deep indentations which divide his torso into four parts, just as would three tightly cinched belts. Why an elephant would wear three belts is still a mystery.

The various stages of prism weathering are obvious at the Maze (to the northwest and west of Dumbo) and at the Fissures (to the northeast of the huge boulder). See figure 11.

The joint system shows as marked grooves and lineations on aerial photographs of the area, and the northwest and east-by-northeast topographic grain is strikingly distinctive. Further evidence of the topographic and rock grain is shown by the Graniteville topographic map. A line projected along the southwest margin of Buford Mountain also trends northwest-southeast, parallel not only to one joint system in the Elephant Rocks area, but also the chain of granite and porphyry mountains in the general area.

The hard-surfaced Braille Trail is designed for those with visual and other physical handicaps — despite the fabled problems of the visually handicapped in interpreting the morphology of elephants!

A quarry, opened in 1869, furnished part of the stone for the Eads Bridge piers and cobbles for St. Louis streets as well as granite for the Illinois and Iowa statehouses. Other quarries north of the Elephant Rocks supplied granite for many major buildings in St. Louis, for Washington University buildings, and for the turned columns in the front porch of the Governor's Mansion in Jefferson City. Swallow (1855, p. 134) refers to quarrying at the Elephant Rocks as early as *circa* 1845.

The Thomas Allen monument at Pittsfield, Massachusetts, is of "Missouri Red" granite and is a worthy representative, being a single polished column 42 feet high and 4 feet 2 inches square at the base. Granite from quarries in this area was used in the Marshall Field Building in Chicago, and in major buildings in New Orleans, Dallas, Baltimore, San Francisco, Pittsburgh, and many other cities in the United States.

Missourians are indebted to a geologist for the Elephant Rocks State Park. Following his retirement as Chief Geologist for the St. Joseph Lead Company, Dr. John S. Brown purchased the property and presented it to the State of Missouri.

In 1978, the Elephant Rocks were designated a State Natural Area (with the exception of the abandoned quarries), and the State Park management plan is designed to maintain the area in its natural condition.

The most convenient access to the park is via a gravel road doubling back west off Highway 21 at the east edge of Graniteville or 0.45 mile west of the Highway H (route to Johnson Shut-Ins) junction. Follow this gravel road for 0.7 mile past an abandoned quarry to the park entrance.

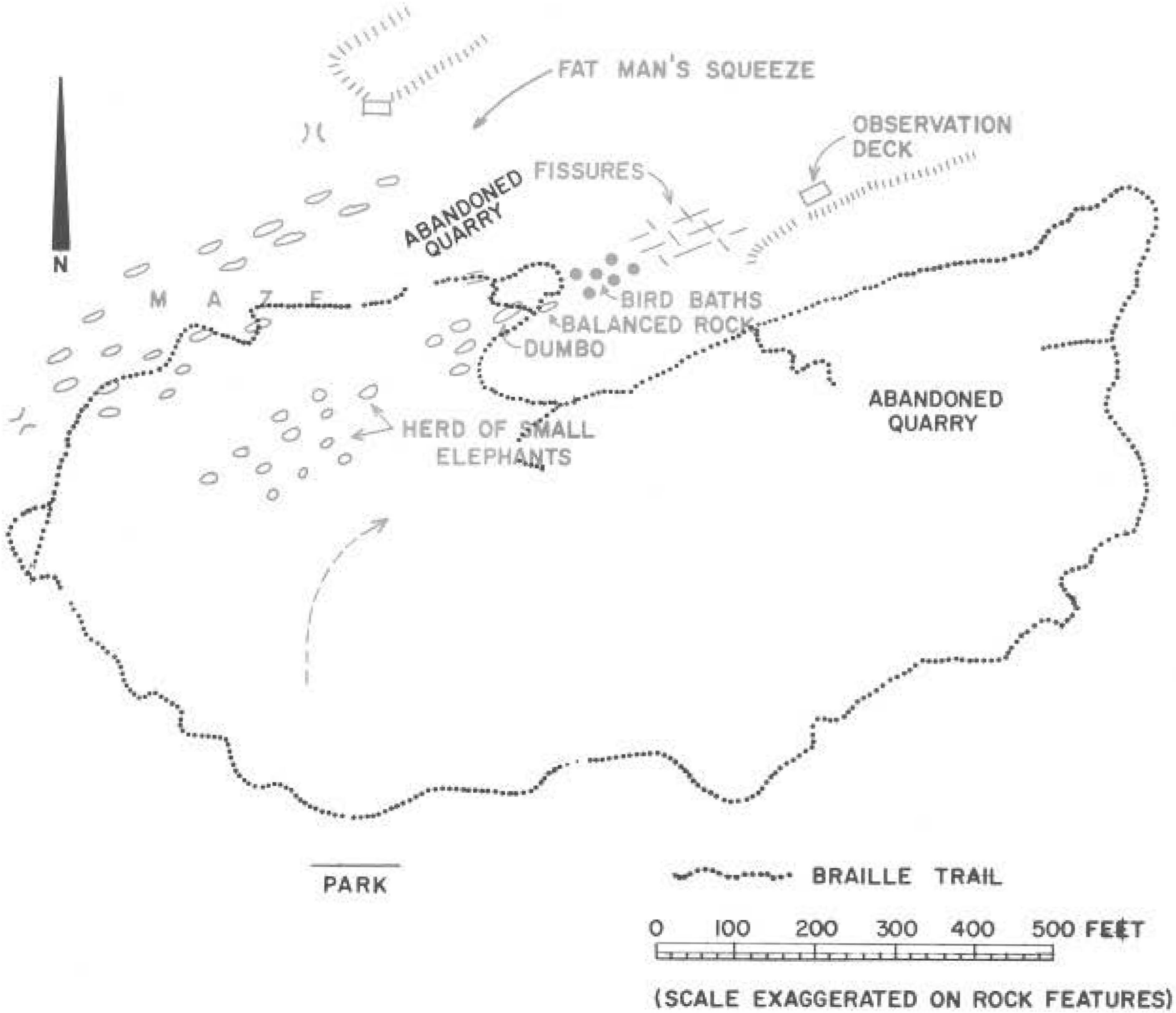

FAT MAN'S SQUEEZE
OBSERVATION DECK
FISSURES
ABANDONED QUARRY
N
MAZE
BIRD BATHS
BALANCED ROCK
DUMBO
HERD OF SMALL ELEPHANTS
ABANDONED QUARRY
PARK
BRAILLE TRAIL
0 100 200 300 400 500 FEET
(SCALE EXAGGERATED ON ROCK FEATURES)

Figure 11

Sketch map of the Elephant Rocks.

10. DEVILS HONEYCOMB

Washington County, 3 miles southwest of Irondale, atop Hughes Mountain, in NE¼ SE¼ SW¼ sec. 28, T. 36 N., R. 3 E., Irondale 7½-minute Quadrangle.

Devils Tower National Monument in Wyoming, Devils Post Pile National Monument in California, and the Giant's Causeway in Ireland are world-famous scenic examples of igneous rock which has cooled to form giant polygonal columns bounded by fractures (joints) created as the once-molten rock cooled and contracted. Hughes Mountain contains a smaller but, by Midwestern standards, a unique and scenic example of the same phenomenon. For this reason, it is hereby christened the Devils Honeycomb. The columns are a bit short for fenceposts, but the polygonal pattern as viewed from above leaves no doubt that the Devil has apiarian interests (figs. 12 and 13).

Hughes Mountain is composed of rhyolite porphyry, once-molten rock with contrasting crystal sizes. The rock is salmon pink but is colored yellow by lichens along weathered surfaces. The yellow coloration produced by these small plants has excited novice uranium hunters in many areas but, unlike the yellow uranium ores, it will burn easily and doesn't cause a Geiger counter to emote.

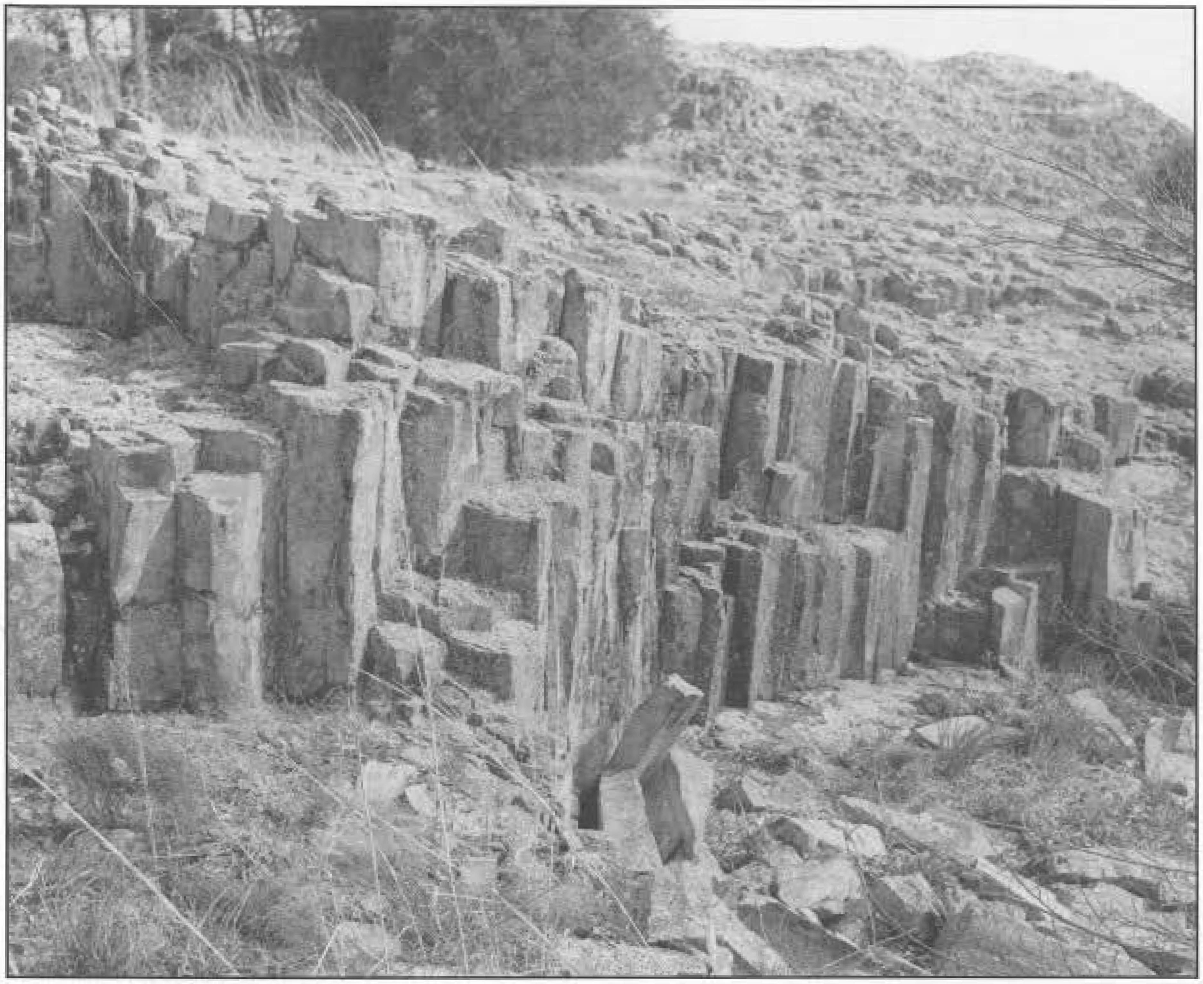


Figure 12

The Devils Honeycomb, atop Hughes Mountain, is a unique example of polygonal jointing in Precambrian rhyolite. Photo by Jerry D. Vineyard.

The columns have from four to six sides, are 8 to 10 inches in maximum diameter, and from 3 to 4 feet in maximum height. The site is well worth the easy climb to it. The mountaintop view is excellent, the top is devoid of brush, and the stairstep honeycomb structures are cooperative subjects for any photographer. The most photogenic exposures are on the south edge of the mountain crest indicated by the heavy 1,200-foot contour line.

Hughes Mountain is most easily reached from Irondale by taking Missouri Highway M to the southwest. From the railroad track crossing at the south edge of town, follow the highway for 3 miles to a gravel road junction on the left (south). Turn left onto the gravel road and follow it for 0.3 mile to the top of a hill. The car may be parked in a pullout on the east side of the road and a footpath (or jeep trail) can be followed for an additional 0.6 mile to the southeast to the crest of the mountain. The walk is easy and well rewarded!

The Missouri Department of Conservation now owns Hughes Mountain. The Devils Honeycomb is part of the Hughes Mountain State Natural Area.

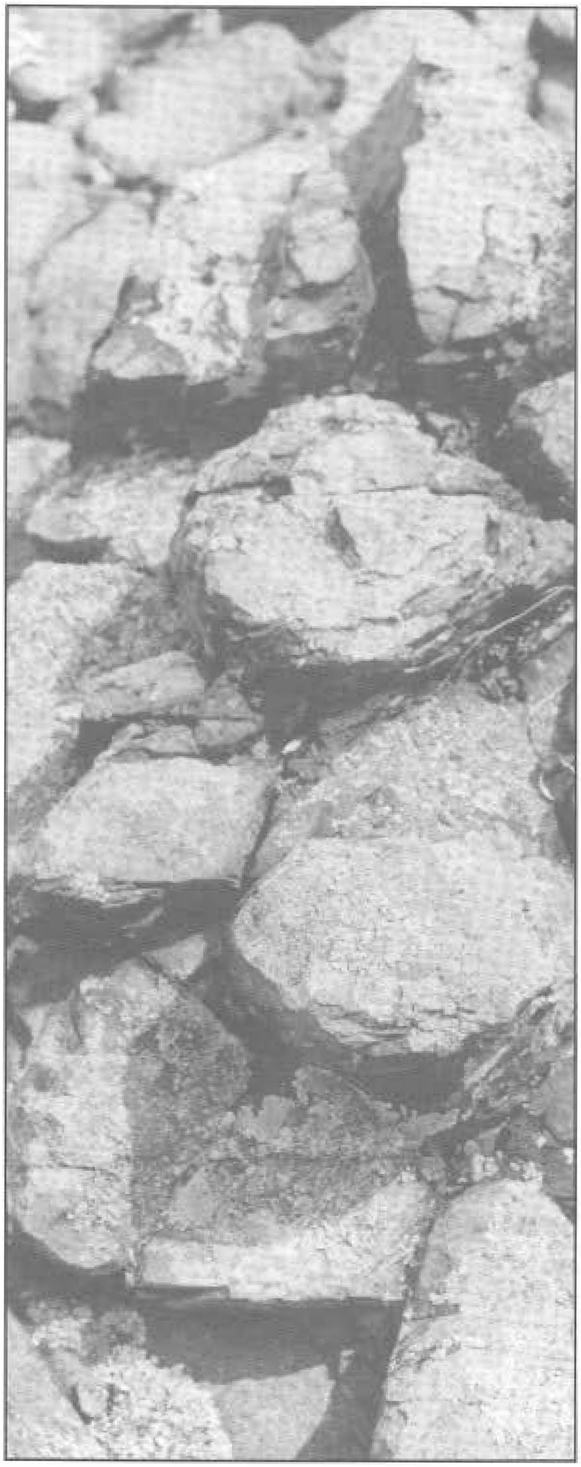


Figure 13

Vertical view of Devils Honeycomb. Columns are 8 to 10 inches in diameter. Photo by Jerry D. Vineyard.

DON'T FORGET TO
CLOSE GATES
AND SAY "THANKS"
BEFORE YOU LEAVE.

THE LINCOLN HILLS AREA

11. THE LINCOLN HILLS

The Lincoln Hills are especially well developed in the area between Highways 61 and 79 from the Troy-Winfield area north to the vicinity of Hannibal. Rocks have been folded into an arch trending northwest between these two highways and erosion has exposed rocks ranging in age from Ordovician to Mississippian.

Steyermark (1951, p. 135) describes a unique flora in the Lincoln Hills as follows:

*"Bordering the Missouri River on the north and continuing north along the western side of the Mississippi River is hilly broken country with chert, sandstone, and limestone outcrops weathering into bluffs, and 'glades.' This region may be considered botanically, if not also geologically, as part of the Ozarks. In certain portions of it occur what may be considered 'nunatak'[1] areas, which, having escaped being covered by the last Pleistocene ice sheets, have preserved their original flora. One such locality is in Lincoln County in an area of St. Peter sandstone. Here occur plants known to grow elsewhere in this state only south of the Missouri River in the Ozark region or confined to the Ozark area north of the Missouri River... In another part of this county, on a limestone glade, occurs Rock-moss (*Sedum pulchellum*), otherwise confined to unglaciated territory to the south. Finally, in Marion County, along the bluffs of the Mississippi River near Hannibal, is the rare species of Shooting Star (*Dodecatheon amethystinum*), known otherwise only from the 'Driftless Area' to the north and unglaciated territory to the east of Missouri. Throughout the region bordering the Missouri River on the north and the Mississippi River between St. Charles and Hannibal and slightly northward and westward, many species occur which are known elsewhere in Missouri only from the Ozark region."*

12. THE PINNACLE

Pike County, at north edge of Clarksville on Highway 79, in south part of secs. 8 and 9, T. 53 N., R. 1 E., Clarksville and Pleasant Hill West 7½-minute Quadrangles.

The Pinnacle at Clarksville, with an elevation in excess of 840 feet above sea level, is advertised as the highest point on the Mississippi River. A skylift has been constructed to the top of The Pinnacle, where excellent concessions leave the feeling that the price of the lift is a most reasonable one. Those who fear heights may not enjoy the skylift to its fullest, but even if they do not they certainly will be well rewarded at the top of The Pinnacle. Included among the developments are excellent reconstructions of various types of pioneer business and craft enterprises and fine collections of artifacts and antique tools.

The area and concession were willed to Culver Stockton College in 1969 and the college has carried on archaeological digs on the hill, preserving the Indian burials under cover for public view. An archaeology and geology museum rewards the serious as well as the casual observer. The burials were in loess, the windblown silt and clay which has a peculiar property of standing vertically when it is in place, and the geologic cross section in the museum shows the rock formations of The Pinnacle representing four geologic periods (Ordovician, Silurian, Devonian, and Mississippian) as well as the Ice Age loess. An observation tower and deck permit a view of the knobs of the Lincoln Hills which are followed by Highway 79 from Hannibal to Elsberry. One can also enjoy watching river traffic going through the locks and the panorama of the 5-mile-wide Mississippi River Valley with the Illinois bluffs on the opposite side.

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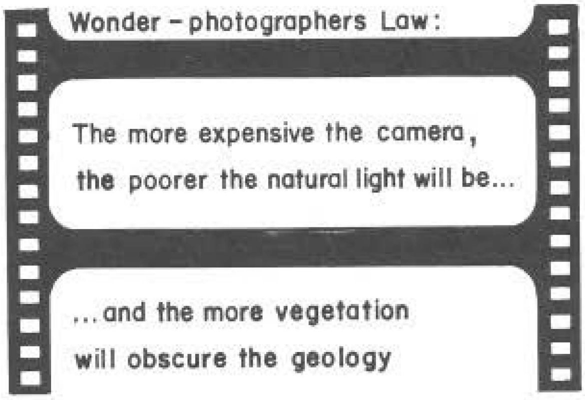
[1] A nunatak is an insular hill or mountain surrounded by an ice sheet.



Wonder - photographers Law:

The more expensive the camera, the poorer the natural light will be...

...and the more vegetation will obscure the geology

BALDS

Typically, a bald is a mountain with a glade type of vegetation, i.e., a grassy open area surrounded by timber. Balds are generally composed of Lower Ordovician dolomites although some are capped by Mississippian limestones. Should they contain any trees, the cedars (junipers) will tend to predominate because that tree is best suited to an exceptionally thin topsoil and the carbonate rocks.

The Gainesville 15-minute Quadrangle (and the Gainesville, Gainesville NW, Sycamore, and Udall 7½'s) best shows the problem of naming upland promontories in the Ozarks. It is in Balds country and exemplifies the use of *bald* as both noun and adjective as in Ludecker Bald and Bald Dave. In addition to balds, this quadrangle contains hills whose proper names include the terms knob, pinnacle, mountain, and hill. Two of the many points in Missouri named Pinnacles, namely Pinnacle and Little Pinnacle, lie 3 miles northwest of Gainesville.

The Shepherd of the Hills country northwest of Branson is near the western limit of the Balds and contains one of the very famous ones, Dewey Bald near Old Matt's Cabin. To the west and north of the Bald country, hills tend to become more linear and are commonly designated as ridges.

13. BALDKNOBBER MEETING SITE

Taney County, in center S½ sec. 26, T. 23 N., R. 21 W., 2.5 miles northeast of Branson and 0.15 mile southeast of Oak Grove Church, Branson 7½-minute Quadrangle.

Lucille Morris Upton (1939) published a comprehensive history of the Baldknobbers, a very readable account of violence and tragedy in southwestern Missouri. The Baldknobbers were a group of vigilantes formed to combat the lawlessness of post-Civil War days (fig. 14). As is often the case, these vigilantes became overactive and murders resulted, culminating with the hanging of three Baldknobbers on May 10, 1889 at the Christian County Courthouse in Ozark.

The group organized in 1884 or 1885 and held its meetings on a knob variously known as Bald Knob, Big Bald, or Snapp Bald. The location of this meeting site was verified by Elmo Ingenthron (1972), of nearby Kirbyville, who has made an intensive study of Baldknobber history and who conferred with Frank Hall, owner of the land on which the knob stands. He reports that Mr. Hall pointed out the circle of rocks where Baldknobbers built their fires and where a flag visible for miles was hoisted from among these rocks.

In the past, the Bald contained fewer cedars and thus was more representative of its name. Mr. Ingenthron marked the Branson topographic map to show the location of a permanent spring 0.26 mile northeast of the Oak Grove Church on

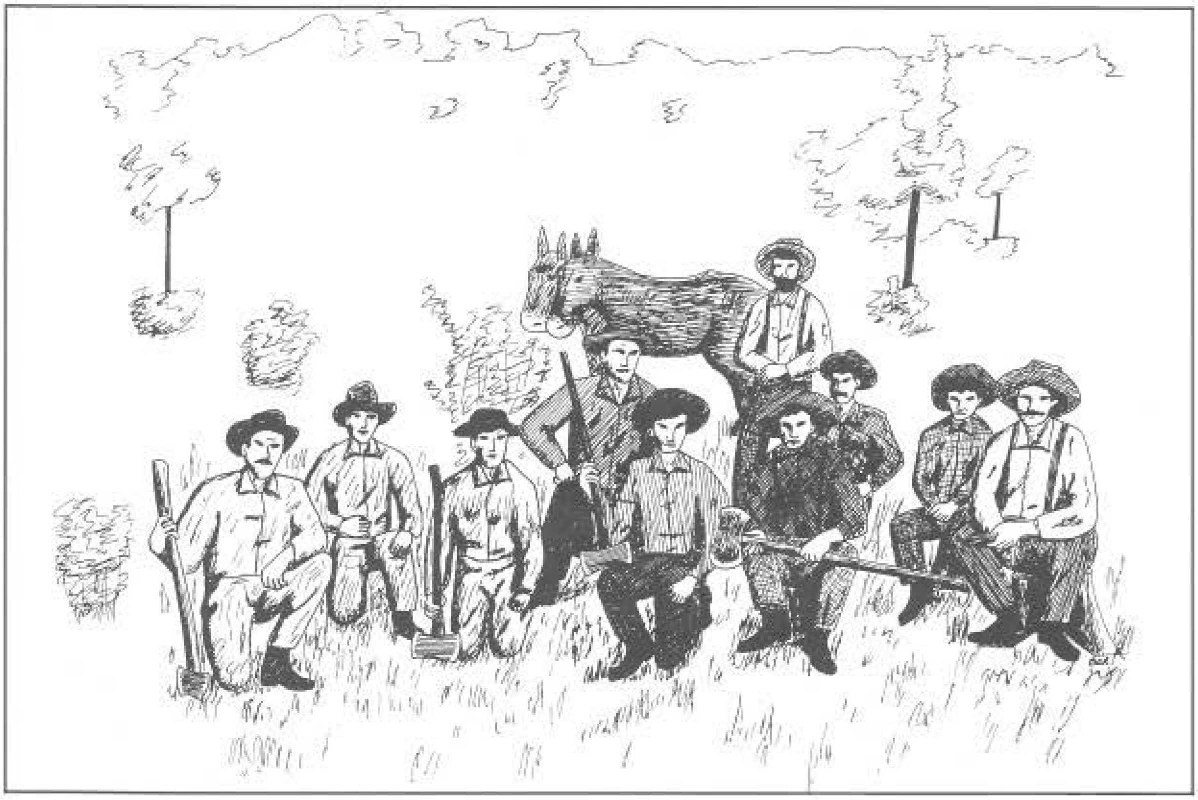


Figure 14

A group of Baldknobbers gathered for a crime-breaking foray. Drawing by Billy G. Ross, based on a photo from The Ozarks Mountaineer.

the 980 contour line where it V's to the southeast. About 150 to 200 feet north of the spring, some foundation rock remains, marking the Oak Grove log school location. At this site Captain N.N. Kinney, the original chief of the Baldknobbers, shot and killed Andrew Cogburn in 1886. Captain Kinney was subsequently shot and killed by an anti-Baldknobber in 1888.

The site was reached by taking Highway 160 east from Branson to the junction with Highway T and then north for 1.6 miles where the knob is on the northwest or left side of the road. Those using the topographic map will note a discrepancy in spelling. Upton (1939, p. 53, reprinted 1970) named the bald "Snapp" whereas the topographic map shows it as part of a sequence called "Snapp Bald." This chain of balds is typical of those in southwestern Missouri which are formed on thin-bedded "cotton rock" of the Jefferson City Dolomite.

14. GLADE TOP TRAIL FRACTURES

Ozark County, 4 miles south of Smallett and 11 miles south of Ava, on southwest side of Glade Top Trail, in NW¼ SW¼ SE¼ north square mile, sec. 4, T. 24 N., R. 16 W., Smallett 7½-minute Quadrangle.

Major fracture systems can be expressed in a number of manners. Bluff lines may be abnormally straight, sinkholes may be elongated and trend in preferred directions, cave passages may be very geometric in pattern, or vegetation may show a marked lineation where it follows fracture systems. The last situation is well exemplified along Glade Top Trail in Mark Twain National Forest. Aerial photographs in sec. 4, T. 24 N., R. 16 W., Ozark County (fig. 15) show a marked lineation of trees forming northwest-trending stripes across the bald-glade hills where fractures cut dolomites of the

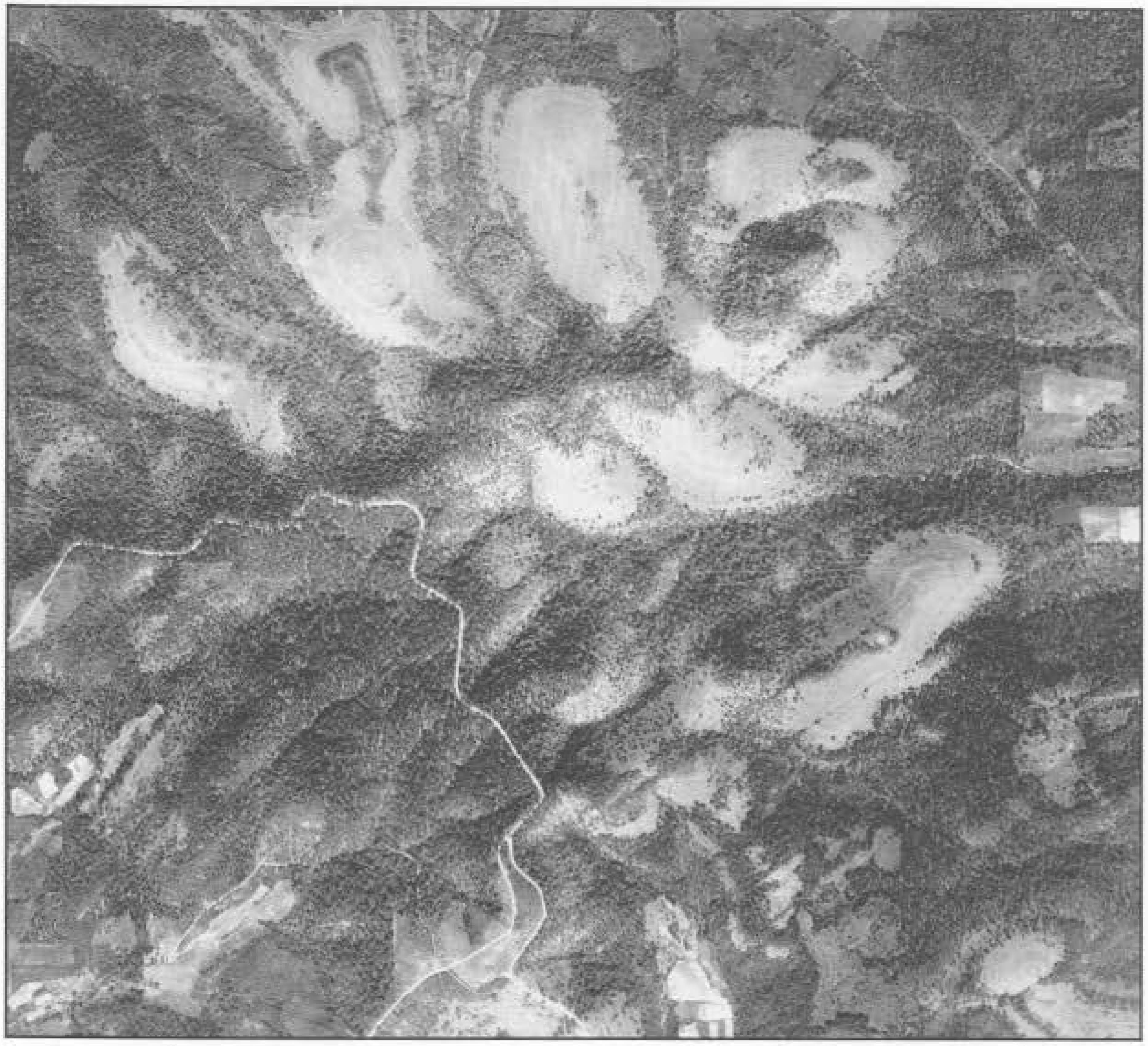


Figure 15

Trees form northeast-trending stripes where fractures cut Jefferson City dolomites along Glade Top Trail in Mark Twain National Forest. Aerial photo courtesy U.S. Dept. of Agriculture.

Jefferson City formation and vegetation finds a foothold in crevices as well as a bit more water than is available atop the bare dolomite. C.E. Boulson, of the Sho-Me Power Corporation, recognized and described this lineation in 1960 (p. 16). He photographed one of these stripes on the ground at an optimum stage of vegetation development to show the line of trees cutting across the dolomite ledges at right angles. The casual observer might confuse this lineation with trees following a fence row, but the many parallel examples trending N 55° E leave no doubt that this is a natural phenomenon and field inspection shows the relationship of vegetation to crevices in the dolomite (fig. 16).

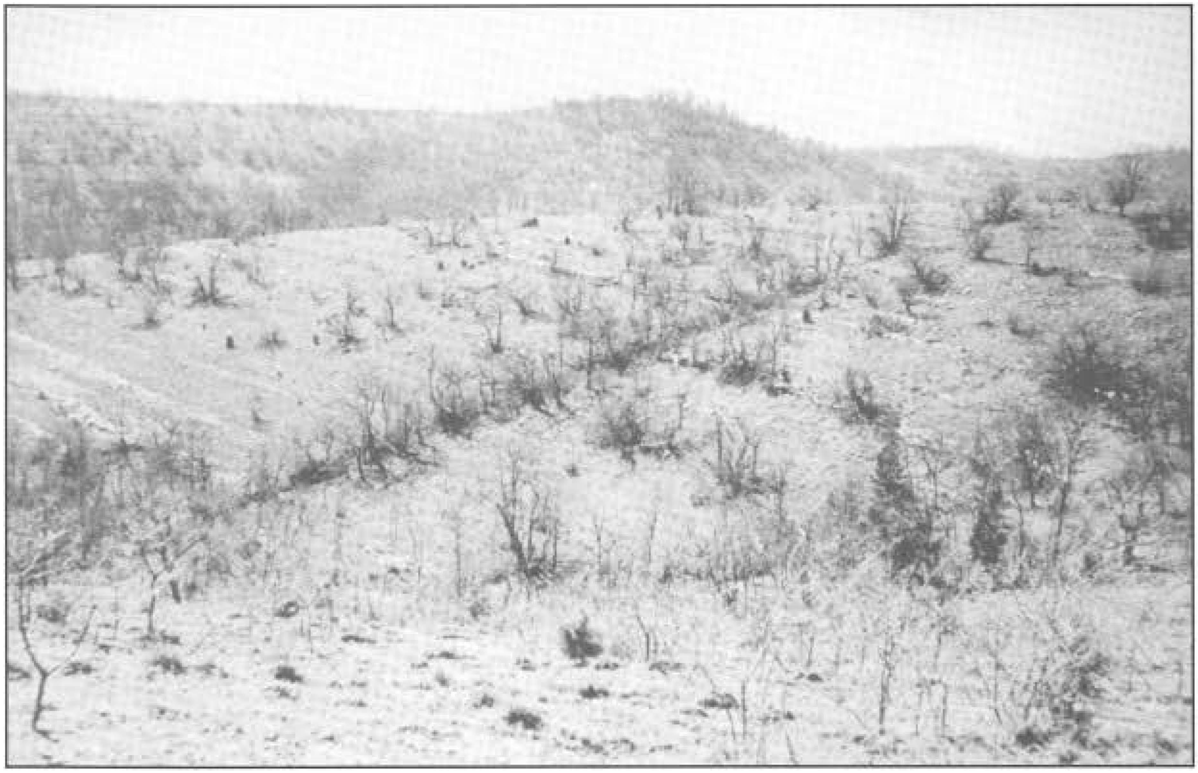


Figure 16

Marked lineations of trees along Glade Top Trail occur where fractures have cut dolomites and created crevices where vegetation can find more water than is available atop the bare dolomite. Photo by C.E. Boulson.

From Ava, the following route was taken:

Miles

0.0 Junction of Highways 5 and A, 5 miles south of Ava; bear right on A.

3.7 Turn left off "A" onto gravel road marked by sign saying "Glade Top Trail" at west edge of Smallett.

7.0 Glade Top Trail sign, bear right staying on trail.

7.4 Pullout on right with large map of Glade Top Tour.

8.7 Smoke Tree pullout on left (east) side of Glade Top Trail. Park at pullout and look in a southerly direction across valley to row of trees climbing hillside at right angles to valley. The lineation is very conspicuous, but a color slide taken in the spring of 1974 was not as dramatic as Mr. Boulson's photograph taken circa 1960 when vegetation was less profuse. At the pullout, the exposure of Mississippian limestones directly overlying Ordovician dolomite forms a bench on the north side of the parking area. The limestones are fossiliferous, containing many button-like remnants of crinoids which grew in seas that once covered the area.

A visit to the area would not be complete without continuing on the Glade Top Trail southwest to Highway 125. The Mark Twain National Forest map of the area, a very useful guide, can be obtained from the Forest Service in Rolla. Geology students would be especially interested in the Ava Quadrangle which shows further evidences of lineation in the form of northeast-trending ridges in sec. 33, T. 25 N., R. 16 W.

15. BREADTRAY MOUNTAIN

Stone County, on northwest side of Highway H, 3 miles northwest of junction with Highway 13 at Lampe, in E½ sec. 35, T. 22 N., R. 24 W., Lampe 7½-minute Quadrangle.

This knob, rising to 1,354 feet above sea level, deserves recognition for its associated legends (fig. 17). Rayburn (1941, p. 304-306) recorded this lore as follows:

"The name was applied by early pioneers because of the peculiar topography of the promontory. Breadtray has a legendary reputation seldom paralleled. It is a landmark of strange incident and hillfolks carefully avoid it. Of the many stories connected with it, four are outstanding.

"Long ago there lived a band of Chickasaw Indians in the vicinity of Breadtray Mountain. They had discovered deposits of silver and they manufactured crude jewelry which they used as a medium of exchange. These ornaments became so popular that they decided to use the cave under the mountain as a workshop, and as a place of safe storage for their silver. They continued this work for many years, but finally were overcome by an enemy tribe and forced out of the region. Before leaving, they hid their treasure in a secret passage of the cave and sealed the entrance. Legend declares that they never returned and that behind some wall in the bowels of Breadtray there lies that vast treasure of the Chickasaws.

"Another legend says that an Indian village was located on the top of Breadtray Mountain. The tribe was haunted by starvation and ill fortune. One day a beautiful girl from a neighboring tribe came to them with the startling information that the Great Spirit would bring them peace and plenty if she became the bride of the chief's son. The wedding took place and the tribe's misfortunes came to an end. The girl was greatly respected by everyone except the medicine man who had profited by the people's misfortunes. He cursed the young woman and she immediately left the village, saying that the Great Spirit would banish the tribe from

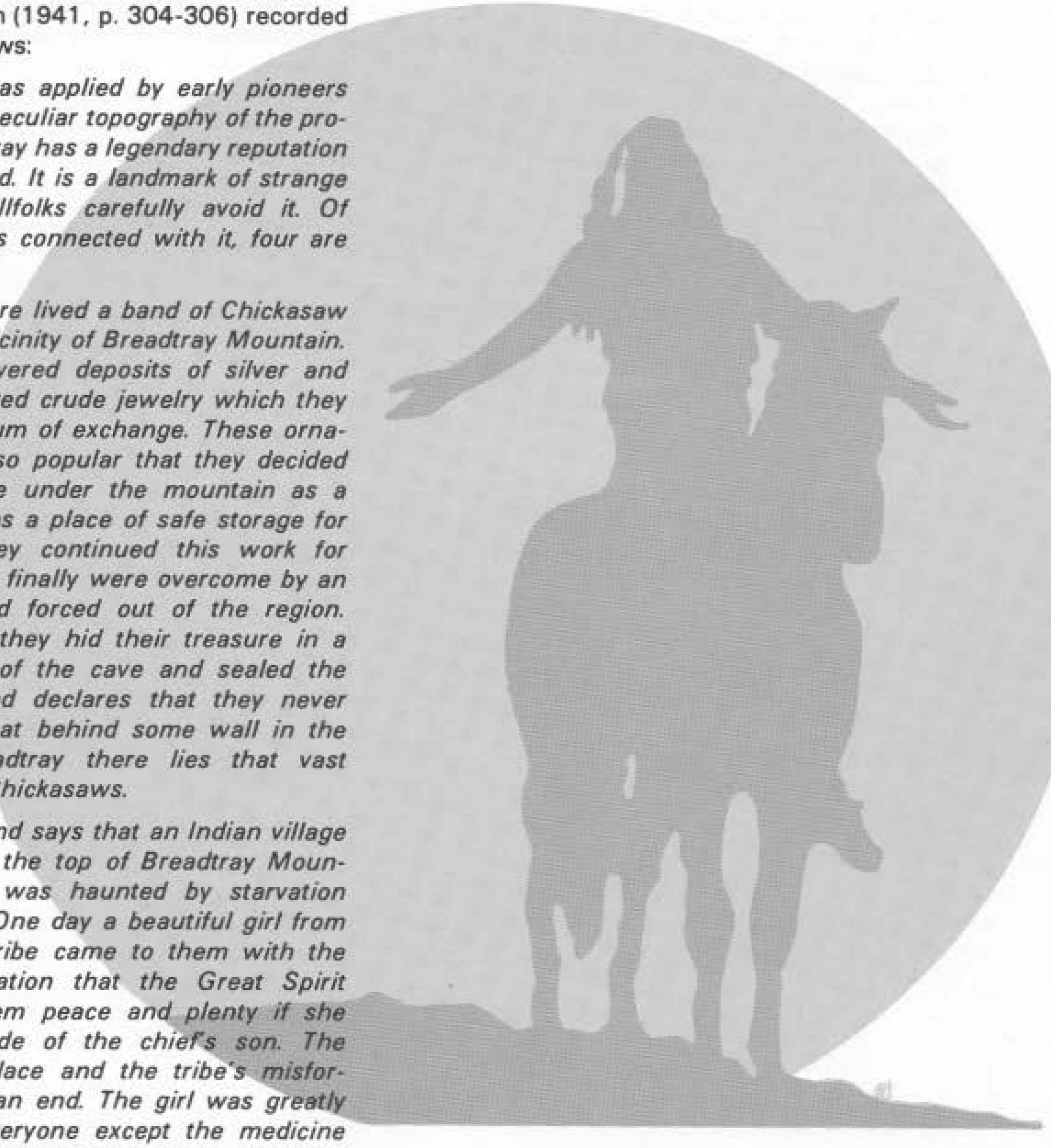


Figure 17

Numerous legends exist about Breadtray Mountain. Drawing by Susan C. Dunn.

the face of the earth. Legend says this prediction was carried out and that the curse even extended to the land on the top of Breadtray Mountain. That is the reason nothing grows on the top of the mountain to this day.

"One of the most popular Breadtray legends has a Spanish origin. The conquistadors mined silver in the vicinity and hid it in a fort on the mountain top. They enslaved the Indians and forced them to work in the mines. When a large quantity of the ore had been mined, the Spaniards decided to leave the country and take fifty Indian girls with them. But the redmen thwarted their plan and killed all but three of the Spaniards, who escaped into the hills. These men returned to look for the treasure, but they were killed by sentries. Since that time many adventurers have sought the lost hoard, which was supposed to be secreted in sealed vaults below the site of the fort, but no trace of it has been found.

"The fourth legend has its setting in the latter part of the nineteenth century. The notorious Baldknobber gang operated in Stone and Taney Counties in the eighties. It is thought that they used Breadtray as a base for their operations and that they cached their loot there. In 1889 the entire gang was captured and executed except one man. He escaped from the jail at Ozark, Missouri, and fled the country. Oldtimers think that he returned to the cave later and recovered the loot."

Randolph (1955, p. 51-53) also cites a legend of the Osages being friendly to the Spaniards, the Spaniards being *too* friendly with Osage belles, and the Osages then becoming unfriendly and exterminating the Spaniards.

MISSISSIPPIAN MOUNDS

The major mounds in western Webster, northern Greene, southern and western Polk, southeastern Cedar, and northeastern Dade Counties are typically erosional remnants formed by siltstones and shales of the Northview Formation, which is Mississippian in age. In some cases, they are capped by still younger Mississippian limestones and in others by sandstones and conglomerates of Pennsylvanian age.

16. FAIR GROVE MOUND

Fair Grove Mound is an example of a Mississippian mound. It is south of Fair Grove, on the east side of Highway 65 in Greene County, in sec. 32, T. 31 N., R. 20 W. (Bassville 7½-minute Quadrangle). This mound is approximately 200 feet high and is capped by Pennsylvanian conglomerates.

17. KARLIN MOUND
18. KING BUTTE

Karlin Mound, a Northview mound in SW¼ sec. 25, T. 33 N., R. 23 W. (Bolivar 7½-minute Quadrangle), is several miles south of Bolivar at the edge of the Bohemian community of Karlin. King Butte, another very famous Northview mound, is noted as a collecting locality for small fossils preserved as pyrite (fools gold) and limonite, a form of iron oxide. It is 10 miles north of Springfield on the east side of Highway 13 in the NE¼ sec. 27, T. 31 N., R. 22 W. (Pleasant Hope 7½-minute Quadrangle).

19. DOVE MOUNTAINS

A lonely outpost of Northview that forms conspicuous elevations is Dove Mountains, located on the east side of Highway 95 between Mountain Grove and Dawson. The highest of these three mountains, all in NE¼ sec. 7, T. 29 N., R. 12 W., is over 1,600 feet above sea level. Other exceptionally high hills in southwestern Wright County are also composed primarily of Northview siltstones and shales. The Northview Formation is named after the town of Northview, south of I-44 between Strafford and Marshfield. This formation contains a siltstone with many fossil worm burrows and is colloquially called "worm rock" in its area of outcrop. It tends to case-harden upon weathering and has been a popular building stone.

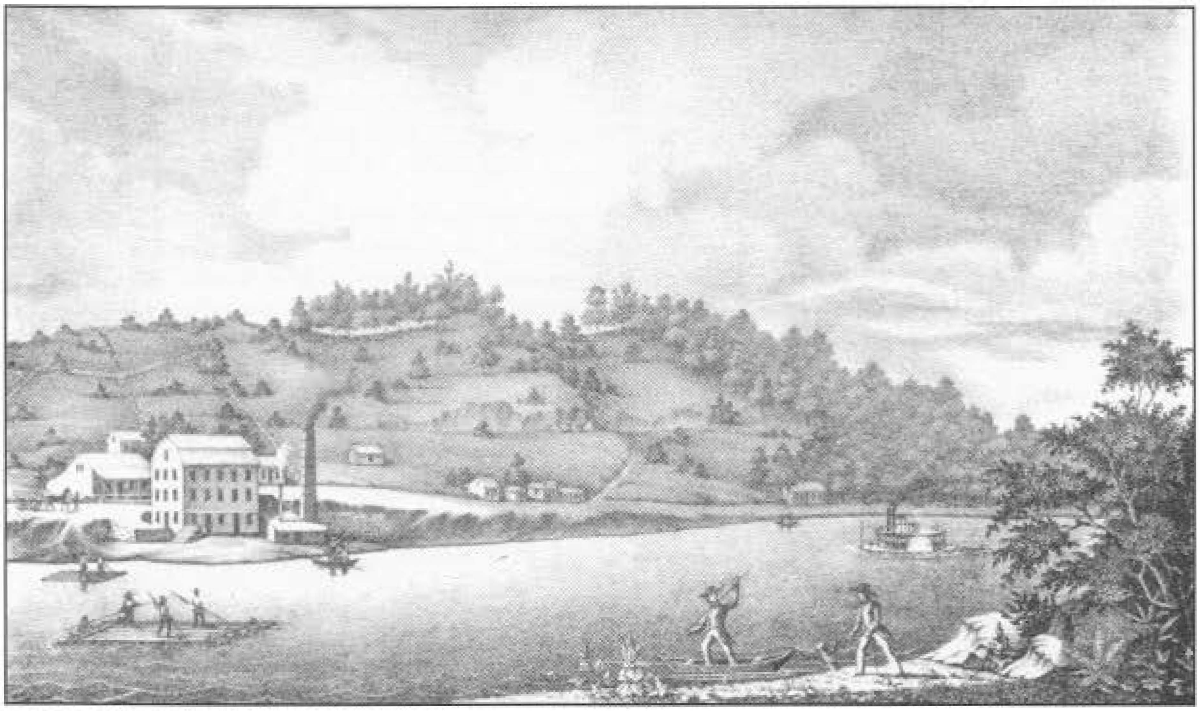


Figure 18

Bluff and steam mill below Weston. Limestones and shales of the Upper Coal series crop out on the slopes. From Swallow, 1855.

PENNSYLVANIAN MOUNDS

The mounds and knobs of west-central Missouri are similar in origin to previously described erosional remnants but are younger in age, being composed of Pennsylvanian shales, limestones and sandstones, and generally owe their existence to a resistant caprock of limestone or sandstone (fig. 18). In extreme western Missouri, these knobs tend to cluster in the counties included in the infamous Order Number Eleven of the Civil War; they extend from Kansas City, south through Barton County, into the extreme northern part of Jasper County and are especially conspicuous along Highway 71 from Harrisonville, south through Lamar. The mounds extend eastward into western St. Clair County, west of Osceola; Henry County, northeast of Clinton; and western Lafayette and eastern Johnson County. The town of Knob Noster and the state park of the same name between Warrensburg and Sedalia represent a fascinating combination of English and Latin to show pride of ownership of local Pennsylvanian knobs.

20. BLUE MOUND

Vernon County, northeast of Nevada and west of Harwood, bounded by Highways M, C, and OO, in secs. 22, 27, and 28, T. 37 N., R. 30 W., named on the Harwood 7½-minute Quadrangle.

Blue Mound is an exceptionally impressive mound standing 200 feet above the surrounding prairie and extending 2 miles long in its highest part. It was used as a burial ground by the Osage Indians, including Chief White Hair, and is still attractive despite the white man's building activities.

21. THE MOUND

Nodaway County, just southwest of Hopkins, in the center of NW¼ sec. 11, T. 66 N., R. 35 W., named on the Hopkins 7½-minute Quadrangle.

The Mound is an isolated hill on the floodplain of the Hundred and Two River, just north of where the river forks into two branches called West and East Forks. The Mound is nearly circular and stands about 40 feet above the surrounding floodplain. Channel straightening along the Hundred and Two River has obliterated the ancestral meandering of the river that led to isolation of The Mound; right-angle bends and long, straight stretches now confine the river's tendency to wander across its floodplain.

22. MOUND BOGARD
23. LONG TATER HILL
24. ROUND TATER HILL
25. STOKES MOUND
26. BLUE MOUND

Similar Pennsylvanian mounds are well developed in Carroll County north of the Missouri River. They are exemplified by Mound Bogard in the N½ sec. 25, T. 54 N., R. 24 W. (Bogard 7½-minute Quadrangle); Long Tater Hill in the NE¼ sec. 36, T. 55 N., R. 24 W. (Coloma 7½-minute Quadrangle); and nearby Round Tater Hill; and by Stokes Mound in the SE¼ sec. 9, T. 55 N., R. 23 W. (Tina 7½-minute Quadrangle); all are on the west side of Highway 65 from the central part of the county to the north line. Highway 65 is at the foot of Stokes Mound between Chillicothe and Carrollton, 0.8 mile south of Highways U and J. Blue Mound, whose crest is in the SE¼ sec. 26, T. 56 N., R. 24 W. (Utica East 7½-minute Quadrangle), in southern Livingston County, to the west of Highway 65, is a similar cousin.

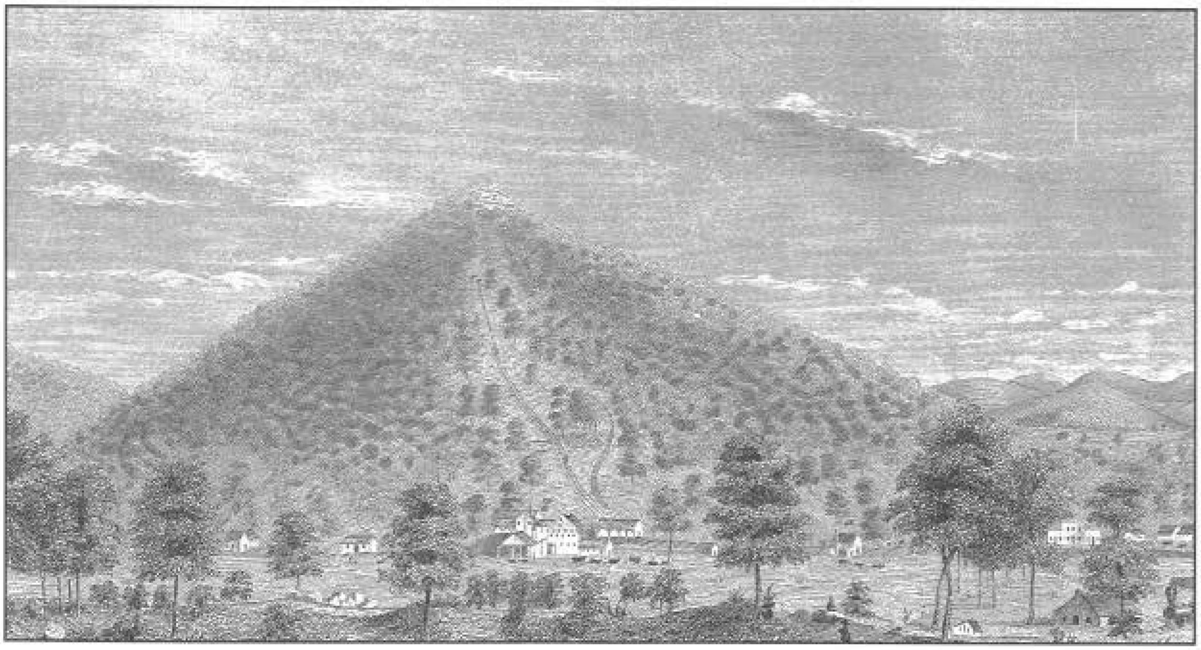


Figure 19

The Pilot Knob, north of Ironton. From Swallow, 1855.

OZARK KNOBS

In the central Missouri Ozarks, the knobs are erosional remnants of various ages but are generally Ordovician, sometimes containing a caprock of resistant Pennsylvanian sandstone and/or conglomerate. No common terminology is used for these hills, but Biblical names are quite popular as are names containing the word "Pilot" suggesting their usage in pilotage navigation by the pioneers.

27.-31. PILOT KNOBS

In addition to the famous Precambrian igneous mountain, Pilot Knob (No. 27) north of Ironton (fig. 19), many other less prominent hills composed of sedimentary rocks have similar names. Pilot Knobs offer their services as landmarks in Gasconade County (No. 28), 5 miles east of Mount Sterling; in Phelps County (No. 29), 8 miles south of Rolla; in Osage County (No. 30), 6 miles northeast of Freeburg; and in southwestern Stone County (No. 31), 2 miles southeast of Viola.

32. LITTLE PILOT KNOB
33. LOWER PILOT KNOB
34. UPPER PILOT KNOB
35. PILOT KNOB
36. PILOT HILL (SAULS KNOB)
37. CAMELS HUMP

Washington County contains Little Pilot Knob (No. 32) between Sullivan and Potosi on the west side of Highway 185, and Taney County has a Lower Pilot Knob (No. 33) and an Upper Pilot Knob (No. 34), north of Devils Den, east of Forsyth. Douglas County boasts a Pilot Knob (No. 35), 5 miles west of Ava on Highway 14 and a Pilot Hill (No. 36), also on Highway 14, in the eastern part of the county east of Richville. One of the more exotic names is Camels Hump (No. 37) in southwestern Crawford County 6 miles south of Cherryville.

SAY
"HELLO"
AND
"MAY
I
GO?"

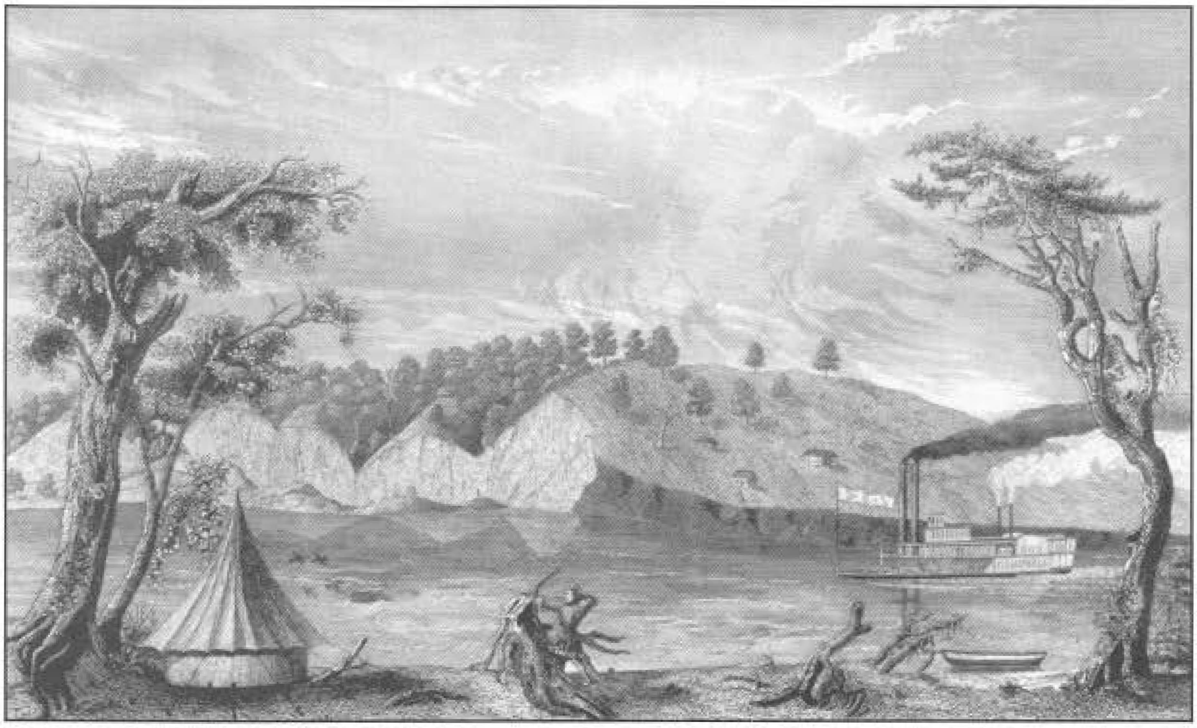
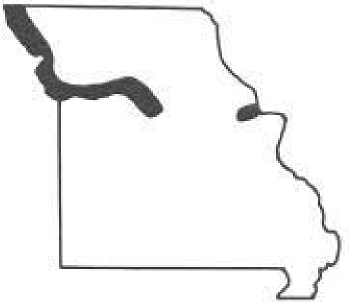


Figure 20

Loess bluffs along the Missouri River above St. Joseph. From Swallow, 1855.



LOESS HILLS

Dune-like loess hills are very well exemplified along the east valley wall of the Missouri River from Kansas City northward into Iowa (fig. 20). Similar deposits are common along the Missouri River Valley downstream from Kansas City to St. Louis, but they become less dune-like and less spectacular as traced toward their junction with the Mississippi River. An exception to the generalization regarding dune-like characteristics is (or was) Les Mammelles (No. 40) at the northeast edge of St. Charles.

Loess is a unique type of silt, usually containing some clay and in some cases fine sand, which has the property of being easily worked, yet being so cohesive that deep cuts with vertical walls may be made in it. The cohesiveness appears to be the result of its being composed of exceptionally fine particles so that molecular attraction acts in part as a bond as well as the fact that the particles are angular and tend to interlock. A third factor may be the presence of plant roots or the filling of the voids left when plant roots rotted. These voids were filled by calcite, a form of calcium carbonate, which forms natural reinforcing rods. Loess of the Midwest was derived from outwash, deposited by meltwater from glaciers during the Ice Age in environments where this meltwater-deposited material was filling up major stream valleys so rapidly that plant growth did not have time to get started and thus anchor it. In addition, cold weather near the margin of the glacier inhibited plant growth. Strong winds picked up this material and deposited it in dune-like hills on the downwind side of major valleys and as a flatter blanket extending many miles downwind from the hills.

Those traveling I-29 northwestward from St. Joseph will have opportunity to see excellent examples of such loess hills along much of the route with especially well developed dune-like topography south of Mound City in the Squaw Creek National Wildlife Refuge near Craig and in the Rock Port area northwestward to Hamburg, Iowa (fig. 21). Thicknesses as great as 70 feet are not uncommon and the dune-like nature of these great dust drifts is especially apparent in the Squaw Creek area (fig. 22).

Deep vertical cuts along roads in the general area of loess hills demonstrate the ability of the material to resist sliding under such conditions. A cut in loess on I-70 immediately east of the Missouri River bridge in the Rocheport area also demonstrates the cohesiveness of this material. One of the disadvantages of loess is that it loses its cohesiveness once it is reworked, a property which must be borne in mind if it be used for fill.

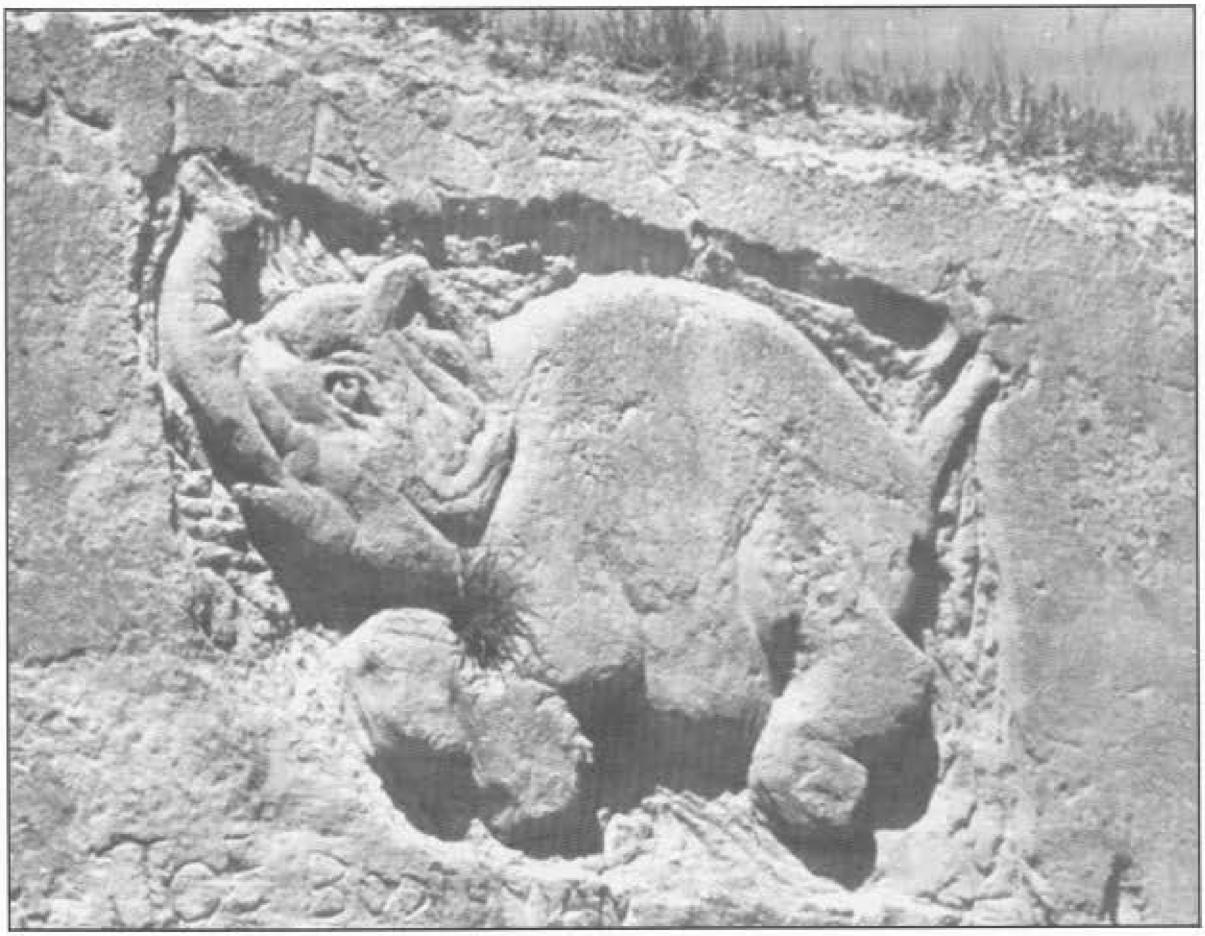


Figure 21

A prehistoric carving? Not at all. This 6-foot elephant was sculpted about 10 feet above the level of Route 36 near Rock Port. Loess is a good medium for "highway art" because it frequently stands in vertical slopes to great heights. Photo courtesy Missouri State Highway Department.

38. THE PINNACLES AND DEVILS BACKBONE

Saline County, 13 miles north of Marshall, in Van Meter State Park area, Miami Station 7½-minute Quadrangle.

The Pinnacles in Saline County consist of serrated ridges of dune-like loess extending from sec. 18, T. 54 N., R. 21 W., southward through the eastern part of sec. 24 and to the center of sec. 25, T. 52 N., R. 22 W. The Devils Backbone is an unusually sharp ridge in the southern portion of The Pinnacles lying in the S½ sec. 24 and the N¼ sec. 25.

At the south end of The Pinnacles in Van Meter State Park, the hiker can easily climb onto Devils Backbone and follow it northward over more of The Pinnacles area if he takes the Centennial Trail starting at the northern part at the main picnic area. The northern extremity of The Pinnacles within the State Park was the site of an Oneota (Missouri) Indian fortress dating back to about 1000 to 1500 AD and has been the object of archaeological studies of the University of Missouri-Columbia.

The photographer might consider driving onto the floodplain of the Missouri River for shots of The Pinnacles and Devils Backbone

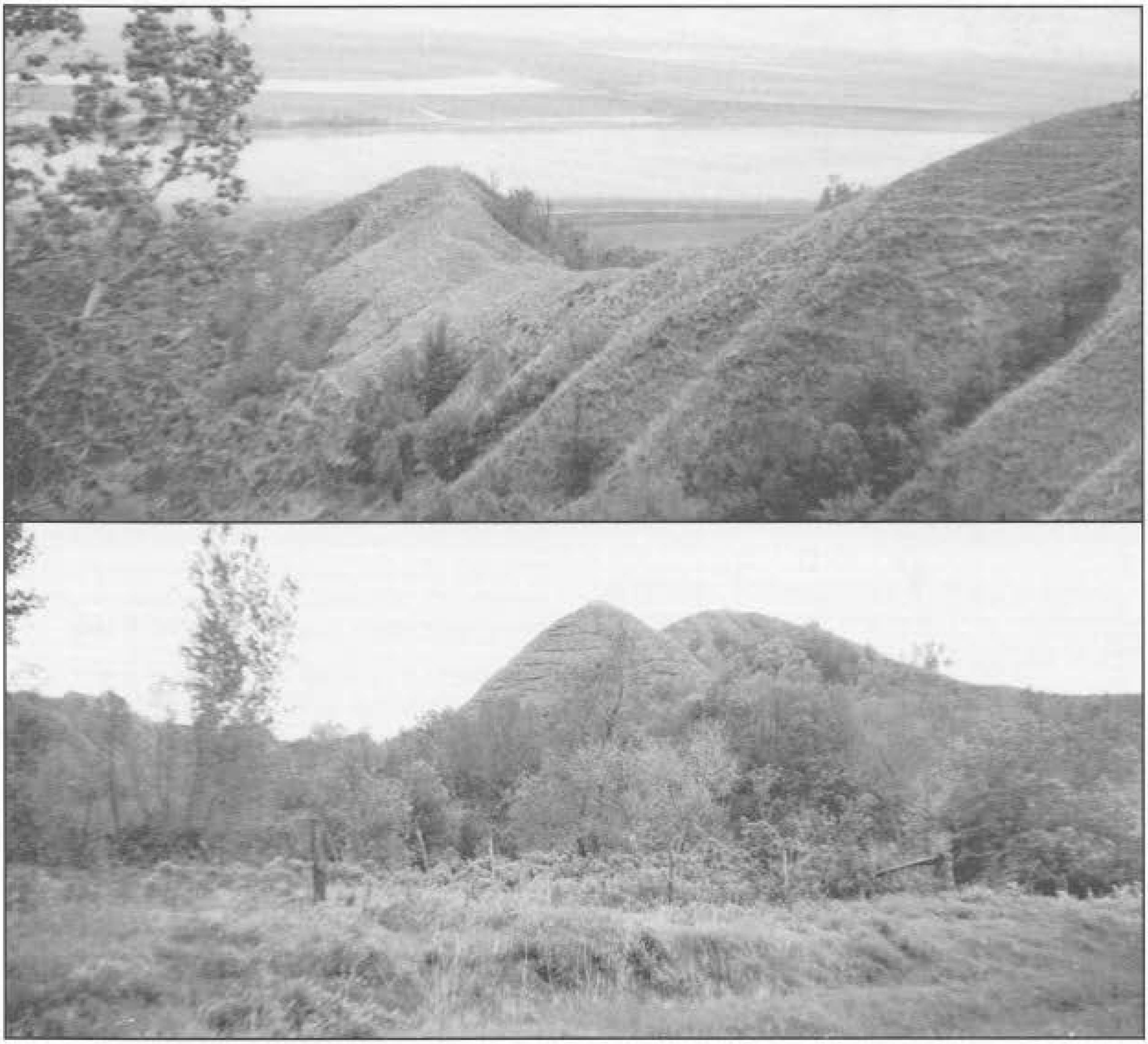


Figure 22

Large loess mounds near Squaw Creek Wildlife Refuge in Holt County resemble a sleeping dinosaur (top) while others nearby (bottom) look like giant haystacks. Photos by Jerry D. Vineyard.

looking east during the winter. During the summer, much of the rugged relief is covered by timber. Time should also be allowed to visit the archaeological exhibit.

39. DEVILS BACKBONE (ST. JOSEPH)

Buchanan County, in St. Joseph, north of Highway 36 and east of Highway 59 (bounded by Duncan and Pacific and 13th and 17th Streets), in W½ SW¼ NW¼ sec. 16, T. 57 N., R. 35 W., St. Joseph South and North 7½-minute Quadrangles.

This site is located by oral descriptions from several sources. According to topographic maps it is north-trending, about a quarter of a mile long, and 100 feet high. Because of its location on the east side of the Missouri River, an assumption that it is composed of loess is logical.

40. LES MAMMELLES

St. Charles County, at northeast edge of St. Charles, 1 mile southwest of junction of Highways 94 and B (area not sectionalized), St. Charles 7½-minute Quadrangle.

Wyoming has its Grand Teton but Missouri has Les Mammelles. They were formed as twin conical hills of windblown loess and were the object of great admiration by early explorers noting them from the floodplain of the Missouri River and also admiring the view *from* them as well as *of* them.

De Finiels *(circa* 1798), on his map of the Missouri-Mississippi Rivers, labels this site with the biologically paradoxical name "Les Trois Mamelles [sic]."

Campbell (1874, p. 284) gives us a view of Les Mammelles and environs in a more primeval setting as follows:

"At this point, where the main body of the bluffs is covered with timber, two smooth mounds, of regular surface, without trees or shrubs, but covered with grass, project into the prairie some distance from the main bluffs. These were named by the early French pioneers, Les Mammelles --. These mounds have an elevation of about 150 feet, and afford an extensive view of a most beautiful country. Many years ago a clergyman was conducted by a friend to Les Mammelles, by the hill route leading through the woods. A beautiful level plain spread out before him for miles, east, west, and north, dressed in living green, variegated with many-hued prairie flowers; the whole encircled by the bluffs of the two rivers, whose crags and peaks, reflecting the rays of the evening sun, presented the appearance of towns and villages and ruined castles. To the north lay the Marais Croche Lake like an immense mirror set in emeralds. For a few minutes the clergyman stood in mute astonishment. When he recovered his speech, he exclaimed, 'I have never before seen anything that gave me a proper conception of the Promised Land!' "

Excavation is destroying them, but their original height can be estimated from modern and old topographic maps as being approximately 30 feet above the general bluff level. In a few years all vestiges of them may be gone, but their memory will be preserved in a namesake street extending northeast across their past location.

Les Mammelles may be reached by driving northeastward out of St. Charles on Highway 94 and going under the Norfolk and Western Railroad tracks; 1.3 miles north of these tracks, Apricot Drive extends to the west (left) off Highway 94 and climbs to the site of Les Mammelles, joining the namesake street which continues southeast to Foxhills Drive. The last remaining vestige was being excavated when the area was visited in June 1972, and if the present description has any value it is purely historical. Erosion and excavations in the general area atop the hills show the peculiar property of loess to stand up in vertical cuts and, despite its softness, to be so tenacious that birds build nests in cavelets in such cuts.

According to Hyde and Conrad (1889, v. 4, p. 2,156), Missouri at one time had another Mammelle in St. Louis whose history they summarize as follows:

" 'Cote Brilliante' is a French appellation, but not derived from the French era. By early French settlers the pretty little mound was known as 'La Mammelle,' a descriptive designation quite correct physically, but to English ears not so delicate as that substituted by Messrs. Coste and Gibson."

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3

Shut-Ins

The term "shut-in" is commonly used in the southern Appalachians to describe a gorge (Kephart, 1913, p. 300), and is but one of the many examples of word use, dialect, and culture transplanted from that area as western migrations produced an Ozark population numerically dominated by peoples from the more mountainous area to the east.

As typically used in the Missouri Ozarks, a "shut-in" refers to a gorge cut by a stream whose valley is locally constricted as it cuts through or between resistant igneous knobs (fig. 23). Upstream and downstream from the shut-in the stream commonly has a relatively wide or open valley and, in some cases, the stream seems to be perverse as it elects to cut a canyon through an isolated mass of igneous rock instead of going around it as a sensible stream would.

Why this perversity? The answer is a geologic enigma and always good for a debate. Three hypotheses are quite common and it may be that no single one can be applied to all cases but any one of them or a combination may be valid for a particular site.

Two of the hypotheses are somewhat similar. One holds that the igneous knobs were, in the far geologic past, completely buried beneath relatively flat-lying sedimentary rock. Streams developed their valleys on the sedimentary rocks and as they wore down the land surface they encountered the once-buried igneous knobs, relics of exceptionally ancient mountains. The streams were committed to their valleys and did not change course as they sawed into the igneous rock just as a saw does not (we hope!) change paths when it encounters a tough, buried knot. Broad-scale erosion removed the sedimentary rocks more rapidly than the igneous and today the streams are locally trapped in canyons which transect the isolated, exhumed knobs.

A variation of this hypothesis starts with an environment of knobs surrounded by, but not completely buried under sedimentary rocks. Streams flowing on sedimentary rocks would seek paths between knobs, but would eventually cut down to form canyons in saddles between knobs. These canyons would be entirely in igneous rock, all of the sedimentary rocks having been eroded away.

The most recent hypothesis considers the knobs to have been prominent surface topographic features before the shut-ins were formed. Streams would attack the knobs by headward erosion and enlarging weak fracture zones in the igneous rock. Ultimately a stream system could cross the knob after a slow but effective history of guerrilla warfare erosion.

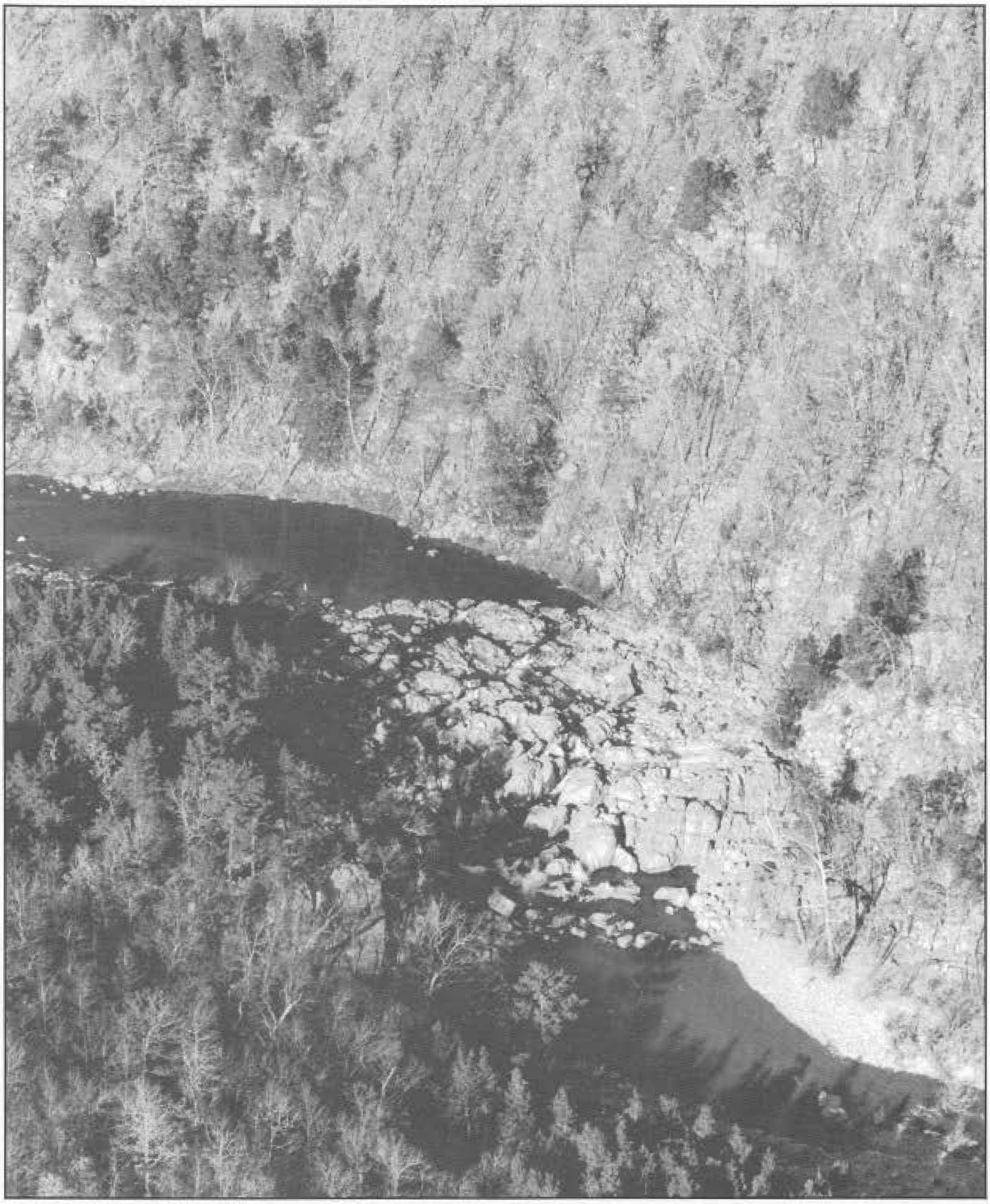


Figure 23

Aerial view of the Upper (Pothole) Shut-in at Johnson Shut-Ins State Park. Fracturing in the igneous rocks is clearly discernible. Photo by Jerry D. Vineyard and James H. Williams.

Intensively fractured igneous rock is commonly exposed in our Ozark shut-ins. This fracturing has contributed to the beauty, helping to produce vertical canyon walls and pinnacles as well as a maze of stream patterns with potholes and water-polished, naturally sculpted igneous rocks.

Studying and describing all of the shut-ins in Missouri would be a major project and, in the interest of time, the most accessible and popular ones are given the most recognition. Some of the best require a considerable amount of time to visit because of difficult access, and the fact that they are not described in detail should not be construed as relegating them to a lower esthetic status.

A majority of the Missouri shut-ins are in the St. Francois Mountains area of Washington, St. Francois, Reynolds, Madison, and Wayne Counties, with Ironton and Arcadia near the center. Another important area lies east of Eminence.

Typical igneous environment shut-ins are discussed and tabulated on immediately subsequent pages followed by streams which have some shut-in characteristics but which do not conform completely to the idealized concept of a shut-in.

41. JOHNSON SHUT-INS

Reynolds County, 14 miles southwest of Ironton at the end of Missouri Highway 178, N½ SW¼ sec. 16, T. 33 N., R. 2 E., Johnson Shut-Ins 7½-minute Quadrangle.

These shut-ins deserve their state park status. They are not the largest of the many in the state, nor are they necessarily the most scenic, but by virtue of their accessibility, potholes, colorful rock, swimming holes, and tasteful development (which has preserved the primeval environment), Johnson Shut-Ins are one of Missouri's top natural attractions (fig. 24).

The plural name of Johnson Shut-Ins has been a source of debate. As viewed on the topographic map, there is but one shut-in; as viewed on the ground, two tandem shut-ins could be recognized if each of the two areas of rapids is considered as a separate shut-in. In fact, visitors quickly identify two shut-ins of distinctly different character.

Those who take Highway H south to the Shut-Ins follow the relatively broad valley of East Fork Black River downstream (fig. 25). At the Shut-Ins they see this same valley constricted in width and greatly steepened in gradient where it cuts through resistant brown, pink, and purple igneous rock (rhyolite porphyry) and a dike of dark diabase in the upstream portion of the most elaborately sculpted area. Erosion has followed vertical fractures (joints) in the porphyry to create a maze of channelways. The major joints trend northeast, at right angles to the orientation of the valley. This valley drains to the southeast parallel to secondary joints, and a third set of joints trending due east has been enlarged by erosion to make the channelways all the more complex.

Potholes are formed at the nearly right-angled intersection of channelways where the direction of flow is abruptly changed. The abrupt changes in direction of flow and the intersecting channelways create local whirlpools where the swirling waters grind out circular holes using sand and gravel carried in suspension as a natural abrasive. Man did not invent sandblasting — he only mechanized it! Deepening of the holes is also expedited by the steep gradient of the stream; some holes are in part plunge pools formed by the impact of water descending vertically and gouging out the bed at the base of individual waterfalls (fig. 26).

The Elephant Rocks, Johnson Shut-Ins, and Mark Twain Cave are all the end result of a chain of geologic events which started with sets of nearly vertical parallel joints inter-

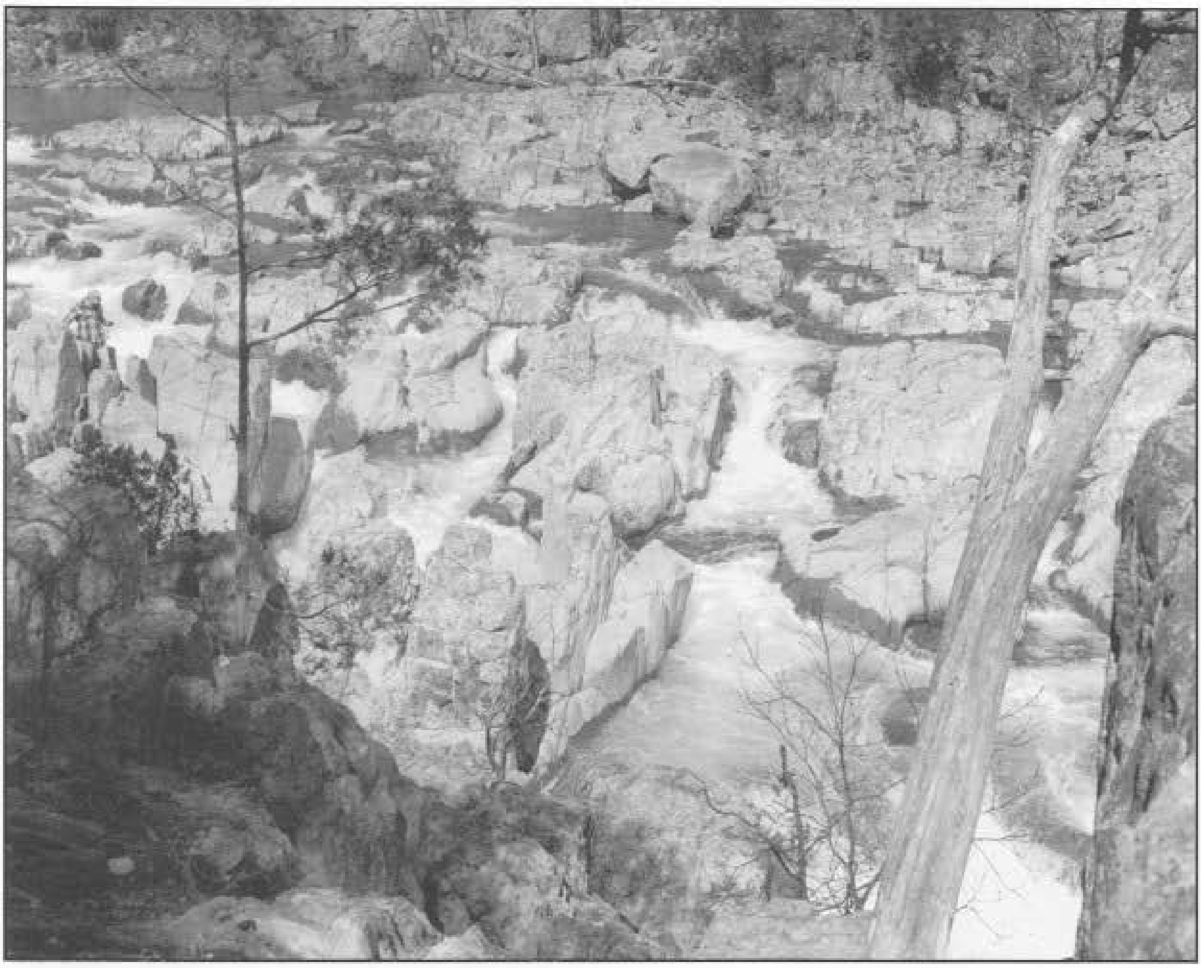


Figure 24

The upper shut-in at Johnson Shut-Ins State Park is called the Pothole Shut-In, because the stream, in crossing an outcrop of highly jointed and fractured igneous rock, has created hundreds of potholes. Potholes form when gravel becomes caught in uneven places in the bed of a stream. The energy of the stream swirls the gravel pebbles against the rock, eroding ever-larger depressions until some become as large as natural "hot-tubs." As potholes grow, the gravel is replaced by pebbles and then boulder-sized rocks, which can be effective eroding agents only in floods large enough to swirl them around. Photo by Jerry D. Vineyard.

sected by other sets of nearly vertical parallel joints. In the case of the Elephant Rocks, jointing of the granite produced huge prisms which were rounded by weathering to produce "elephants"; at Johnson Shut-Ins, joints were enlarged by stream erosion in a canyon or "shut-in" to produce pinnacles and potholes. The subterranean maze in which Tom Sawyer and Becky Thatcher were lost was created by dissolving action of ground water enlarging a complex joint system in limestone.

The Great Falls of the Potomac are similar in appearance and origin to the features at Johnson Shut-Ins but lack the wild, rugged canyon environment. Although the Great Falls are a much larger version of the Shut-Ins, the Shut-Ins win the beauty contest and are well worth the 0.25-mile hike from the parking area — even on a hot July day.

Johnson Shut-Ins may be reached by turning south off Missouri Highway 21 onto Highway N

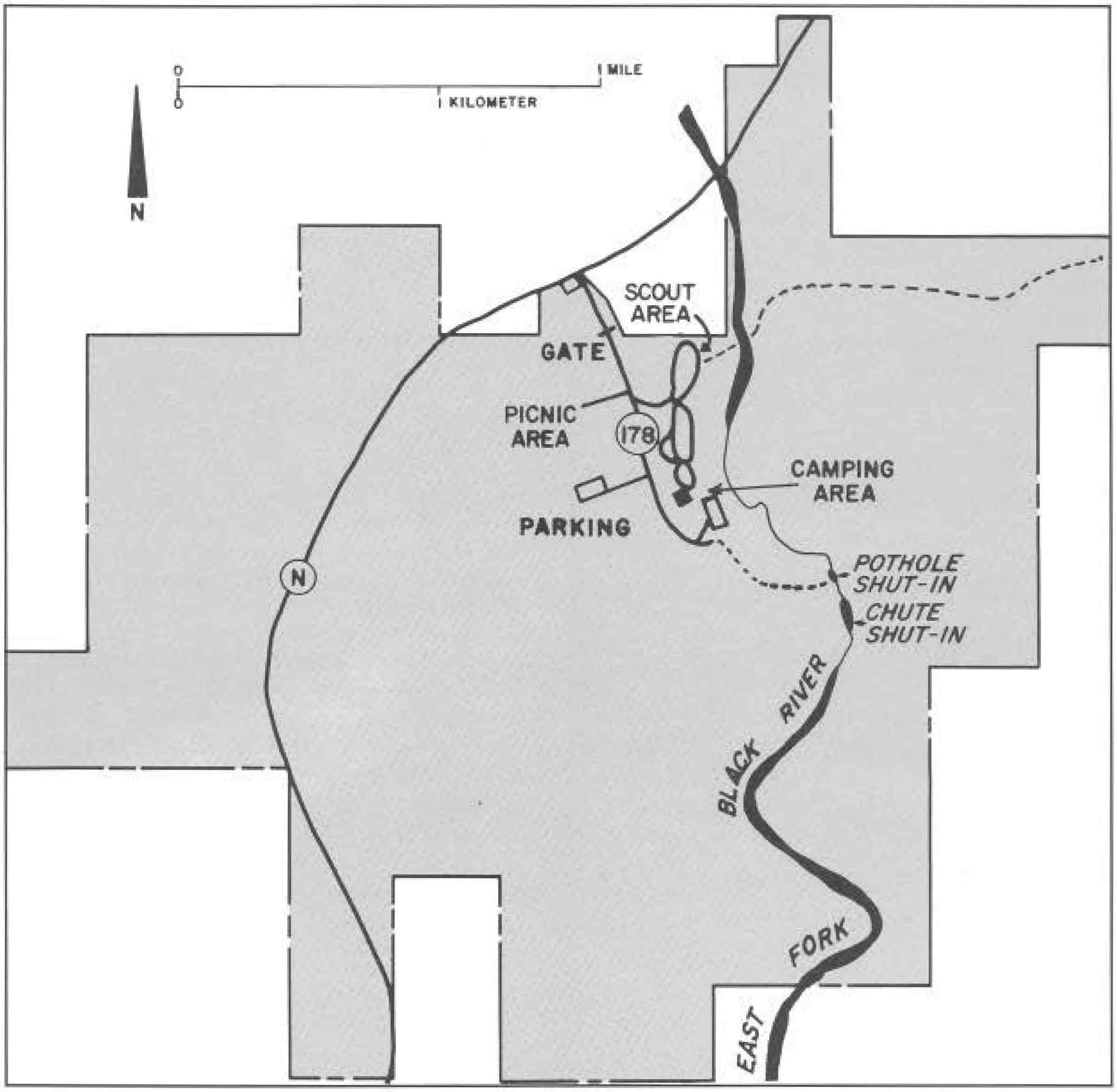

0
0
1 MILE
1 KILOMETER
N
SCOUT AREA
GATE
PICNIC AREA
178
CAMPING AREA
PARKING
N
POTHOLE SHUT-IN
CHUTE SHUT-IN
BLACK RIVER
EAST FORK

Figure 25

Map of Johnson Shut-Ins.

between Graniteville and Pilot Knob, 5 miles northwest of Ironton and following N south for 12.5 miles to the park entrance. Those coming in from the south should turn off Missouri Highways 72 and 49 onto Highway N 3 miles northwest of Lesterville. The park entrance is 7 miles north of this turnoff.

Johnson Shut-ins was designated a State Natural Area in 1978.

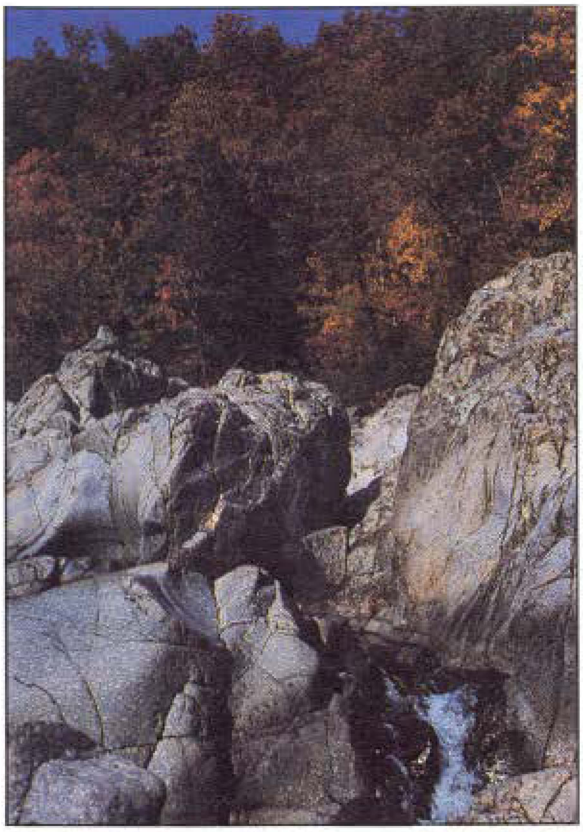


Figure 26

Johnson Shut-Ins rank among Missouri's top natural attractions. Photo by Jerry D. Vineyard.

42. STOUTS CREEK SHUT-INS (LOWER)

Iron County, on Highway 72, beginning 2.3 miles east of junction Highways 21 and 72 at Arcadia, in west-central part sec. 2 and east-central part sec. 3, T. 33 N., R. 4 E., Lake Killarney 7½-minute Quadrangle.

The lower shut-ins of Stouts Creek are well known because of their location on Highway 72, east of the junction of that highway with Highway 21 and Arcadia. These shut-ins are a short distance above, or west, of the head of Lake Killarney and roadcuts expose purple rhyolite, flow breccia (finely fractured igneous rocks), and red rhyolite (fig. 27).

The first iron furnace west of Ohio was on the north side of Highway 21, a few feet east of the bridge across Stouts Creek. According to Elgin (1961, p. 11-13), this furnace was constructed by James F. Tong and Corbin Ashebran and operated from 1816 to 1819 using ore from a nearby deposit and from a mine on Shepherd Mountain at the west edge of Ironton. No remains of this venture are visible today.

Because of the heavy traffic on Highway 72, photographers may wish to park away from the shut-ins and walk into the area.

43. STOUTS CREEK SHUT-INS (UPPER)

Iron County, at end of Highway M, 3 miles west of Ironton, in extreme northeast part of sec. 3, T. 33 N., R. 3 E., Ironton 7½-minute Quadrangle.

The upper shut-ins of Stouts Creek are not as well known to the general public as the lower ones but have the virtue of being on a quiet country road where one may drive slowly or park easily. From Ironton, they are reached by turning west off Highway 21 at Arcadia onto Highway M and following this highway for 3.9 miles past Shepherd Mountain Lake to the terminus of M which joins a gravel road continuing westward.

The shut-ins are slightly over 0.5 mile long and consist of waterfalls in a canyon carved in dark purple porphyry. The most opportune visitation is after a heavy rain when the waterfalls are

IT'S NICE TO VISIT SHUT-INS
(BOTH PEOPLE AND PLACES)
Be Courteous To Both

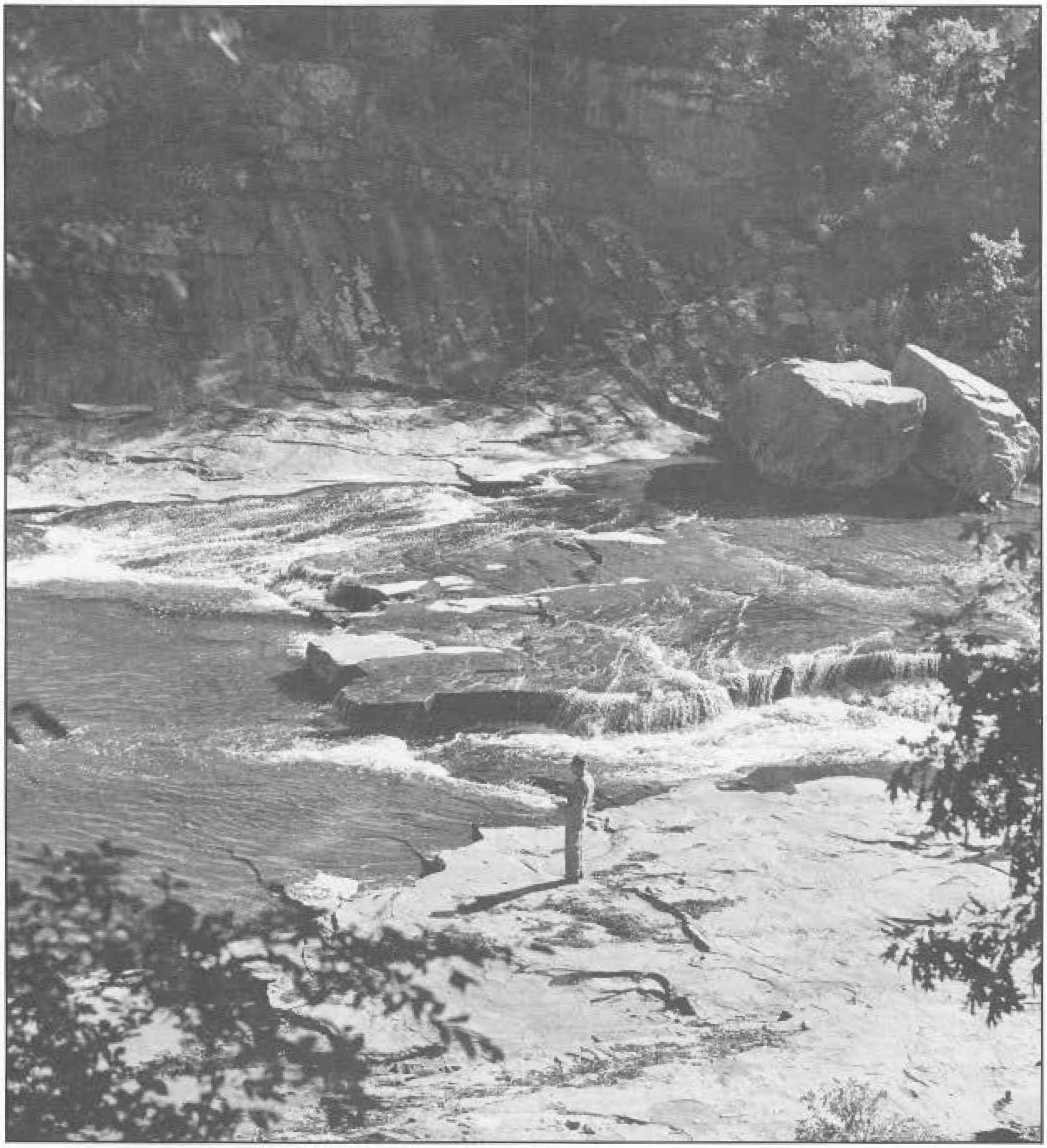


Figure 27

Stouts Creek Shut-Ins (lower). Photo by Gerald Massie.

best developed but, regardless of the timing, the trip is well worth the short drive from Ironton.

Both Ironton and Arcadia have excellent collections of Victorian architecture including the Ursuline Academy at Arcadia and the pre-Civil War courthouse at Ironton with its gingerbread bandstand. The lover of Gothic should also plan a visit to the 1871 St. James Episcopal Church in Ironton.

44. TIEMANN SHUT-IN (MILLSTREAM GARDENS)

Madison County, on St. Francis River, midway between Fredericktown and Arcadia, in extreme south-central part of sec. 2, T. 33 N., R. 5 E., Rhodes Mountain 7½-minute Quadrangle.

Tiemann Shut-In, named on the Rhodes Mountain 7½-minute Quadrangle, was operated for several years as a commercial attraction known as Millstream Gardens. When the first edition of this book was in print, visitors paid an admission charge and were treated to tours of the area by wagon. Today, the land is owned by the Missouri Department of Conservation and has been named Millstream Gardens State Forest.

Visitors can find the area by driving west from Arcadia on Highway 72 to the bridge over the St. Francis River, then 2 miles farther to the entrance road. Alternatively, drive west on 72 from Fredericktown for about 7 miles. If you come to the bridge, you'll know you missed the sign and entrance road; just backtrack 2 miles.

The old wagon trails now make easy walking paths to several scenic overlooks where one may view the beauty of the igneous rock exposed by the ceaseless activity of the river as it carves its way through the resistant rock.

This is a long and especially attractive shut-in. Near the river the rocks have been shaped and smoothed by countless floods; higher on the valley walls, where floodwaters cannot reach, the ramparts are craggy and rough (fig. 28).

Millstream Gardens is a favorite place for kayaking, because this reach of the St. Francis River is considered the most challenging "whitewater" area in Missouri. Kayak races each spring are a tradition here, attracting thousands who watch the excitement from vantage points along the shut-ins, or at several other places downstream toward Silver Mines, where the races end as the watercraft pass through the gap in the block-granite dam at Silver Mines.

Hawksley (1972, p. 108) says of this stretch of the St. Francis River: *"This section should not be run by inexperienced canoeists. In high water it should be run by experts only."* Obviously, watching canoeists run this shut-in is an added attraction, and one stretch of rapids and potholes near the observation deck has earned the title of Baptismal Font. The rapids and elaborately carved rock are excellent for wading, cavorting, or photography. Also, see Wilkes (1977, p. 8-9) for an account of a canoe mishap in this stretch.

The zoologist will appreciate the White-Collared Lizard, the largest and one of the least common lizards in Missouri. He is green and superficially resembles a harmless Gila Monster.

This site should appeal to all age groups and to those with a variety of intellectual interests. It can involve a minimum or maximum of physical exertion, as desired.

Millstream Gardens is a state natural area, managed by the Department of Conservation. A brochure is available that shows the trails, land ownership, and access roads. Below Tiemann Shut-In, the St. Francis River passes through Mud Creek Shut-In just upstream from the Silver Mines area, which is owned by the U.S. Forest Service. There is a campground and recreation area at Silver Mines for the convenience and enjoyment of visitors.

45. ROCKY FALLS SHUT-IN

Shannon County, 9 miles northeast of Winona or 9 miles southeast of Eminence, on Rocky Creek, in SE¼ SE¼ NW¼ sec. 18, T. 28 N., R. 2 W., Stegall Mountain 7½-minute Quadrangle.

Ideally, Rocky Falls should be visited under paradoxical conditions of heavy rainfall but thoroughly dry roads. Fortunately, the latest visitation was made several days after several weeks of April showers. The roads were dry

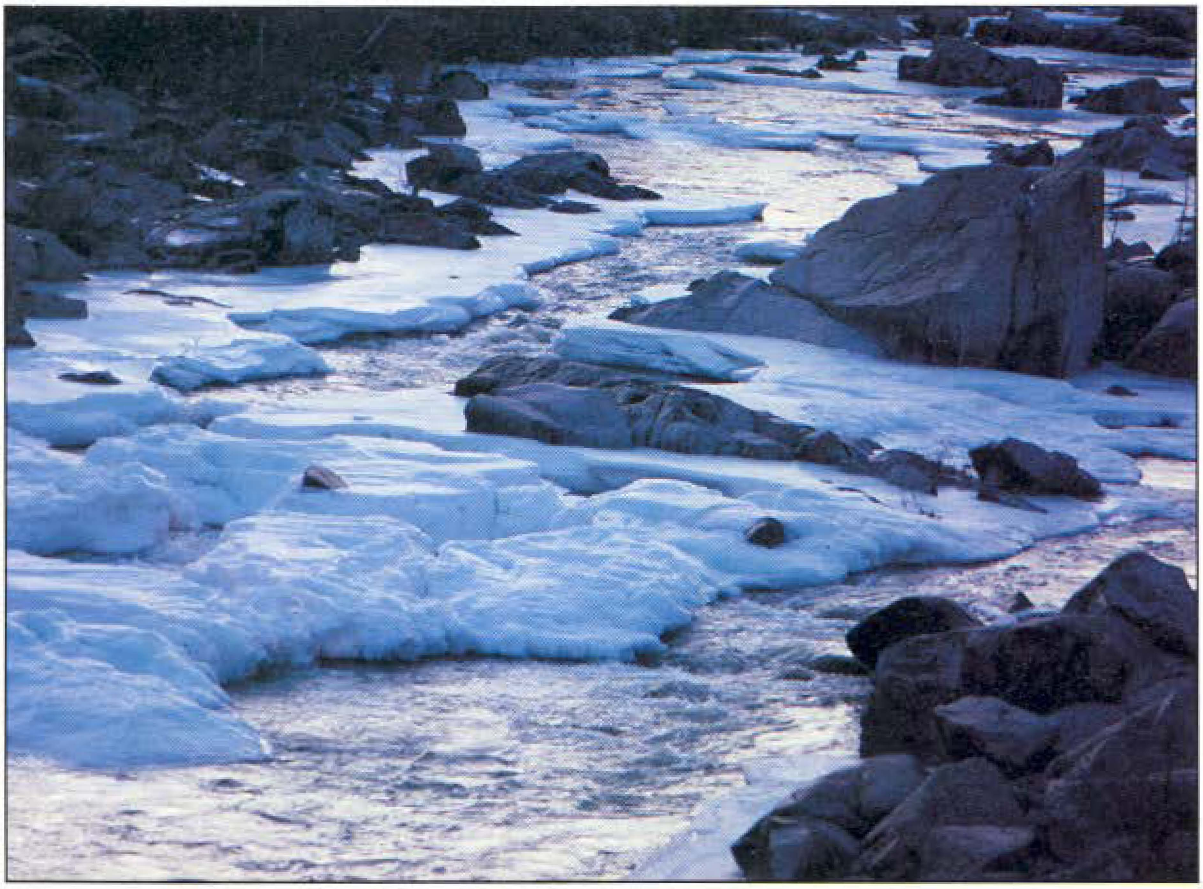


Figure 28

In the spring, the shut-ins of the St. Francis River at Millstream Gardens is a wonderful place for kayaking, but in winter the ice buildup leaves only a narrow channel where the water rushes past igneous rock boulders and jagged ice masses. Photo by Jerry D. Vineyard.

enough to be passable, and the falls were spectacular. Of the alternatives, wet weather is preferable to dry because the falls are a necessary part of the scenery. Autumn is an excellent time because the foliage of the site is exceptionally diversified and there is a virtual kaleidoscopic show in October.

Rocky Creek tumbles in a 40-foot cascade down a steep slope of pink to purple porphyry. A combination of primeval setting with reasonably easy access is a paradox which Rocky Falls comes close to achieving (fig. 29).

From the junction of Highway H and NN southeast of Eminence, take the following route:

Miles	
0.0	*Drive northeast on Highway NN.*
2.0	*Where NN bears left, bear right (south) onto narrow lane-like road.*
2.3	*Bear left at fork. (The right branch comes in above the falls. A muddy ford discouraged driving this route.) Follow road, avoiding temptations to bear left onto timber trails of about the same quality.*
2.45	*Bear right into parking area.*

The falls or cascades drain to the northeast; photographers might prefer to shoot quite early in the morning. This site tempts a revisit!

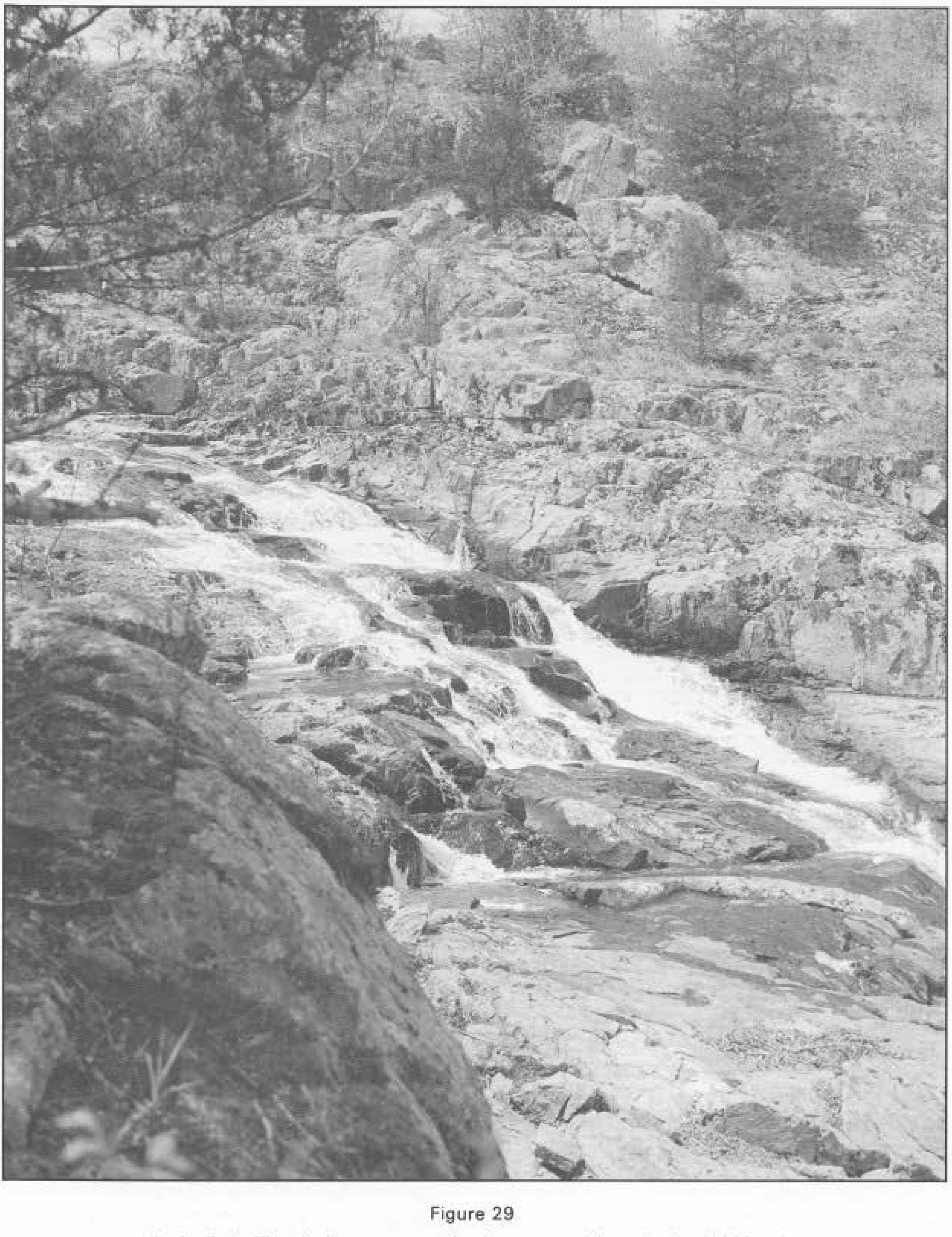


Figure 29

Rocky Falls Shut-In is most attractive in autumn. Photo by Gerald Massie.

46. LON SANDERS CANYON

Wayne County, 1 mile north of Piedmont, in SE¼ SE¼ sec. 14, T. 29 N., R. 3 E., Piedmont 7½-minute Quadrangle.

Lon Sanders Canyon is a shut-in which has gone through one cycle of beautification but now is at the stage where it would improve only through the complete absence of man for a decade or two or if a concentrated effort were made to remove the litter and restore the man-made modifications. It is named after an engraver who became enamored with the site. As a result of his philanthrophy and the interest of a local garden club, extensive stonework was done to make the area an attractive park. Low dams and some of the stonework remain but the canyon is now in limbo between being a natural area and a somewhat distressed developed site. The rock, a dark, coarse-grained porphyry, was quarried in 1883 for cobblestones for use in St. Louis streets.

The potential for and probability of restoration of this area is exceptionally high because of its proximity to Piedmont. A visit through the general area should include a stop at this historic as well as attractive shut-in. Legend holds that this canyon was also attractive to the James and Younger brothers who used it as a hideout after the Gads Hill train robbery on January 31, 1874 (fig. 30). The site was reached by the following route:

Miles	
0.0	*Junction Highways 49 and 34 at north edge of Piedmont. Go east on Highway 34.*
0.4	*Turn left (north) off highway onto gravel road at picnic area.*
1.25	*T-junction. Turn left and follow road southwest and thence north into canyon. As shown on the topographic map this road may be followed by continuing to bear right and returning to the T-junction.*

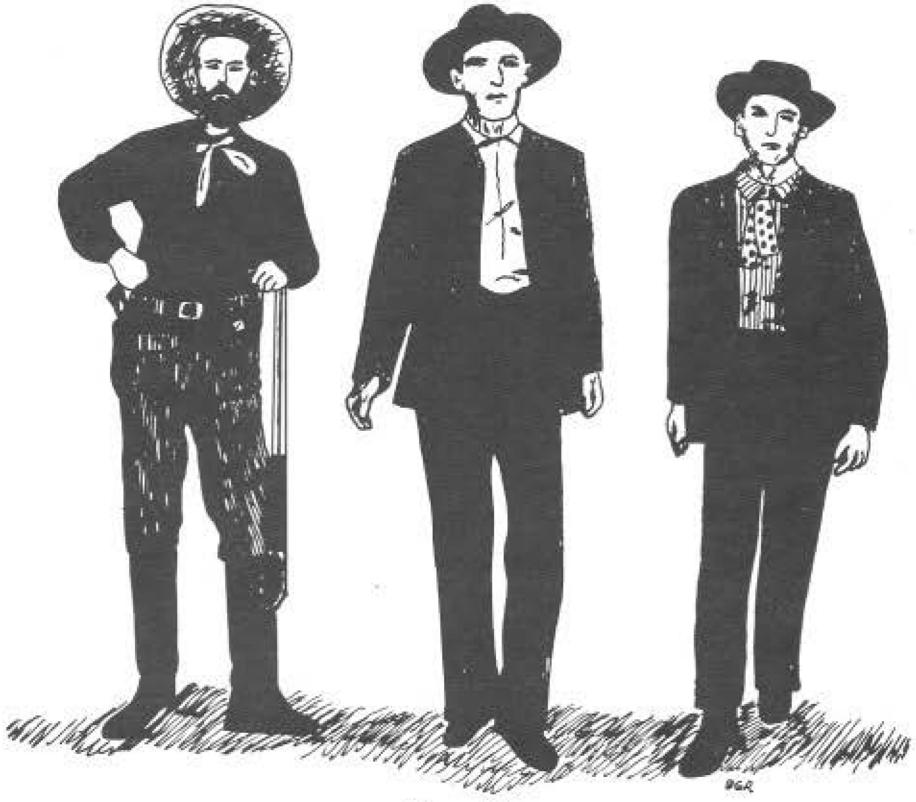


Figure 30

Legend has it that Jesse James and the Younger brothers used Lon Sanders Canyon as a hideout more than a century ago. Drawing by Billy G. Ross.

47. SILVER MINES SHUT-IN

Madison County, 8 miles west of Fredericktown, in Silver Mines Recreation Area, Mark Twain National Forest, on St. Francis River, in secs. 12 and 13, T. 33 N., R. 5 E., Rhodes Mountain 7½-minute Quadrangle.

Accessibility combined with a large area make this a shut-in which can stand a high visitor load. This area is in the same competitive class as Johnson Shut-Ins and Tiemann Shut-In by virtue of its elaborate stream sculpting of rock, sheer jointed bluffs, and an excellent stand of pine. In addition, foot trails along the river on the east rim lead into an area of weathered granite boulders described as "Balanced Rocks" on the Forest Service brochure. This brochure is a very useful guide and also shows the location of igneous intrusions (dikes) into the granite.

The area is reached by taking Highway D southeast of Highway 72, 6 miles west of Fredericktown, for exactly 4 miles to the parking area on the right on the near side of the St. Francis River. The pine-studded bluff opposite the parking area invites photography but the fact that it faces north should be considered in planning photographs. Vertical fractures in the bluff have produced a columnar pinnacled structure and green lichen growths on the rock have, in part, masked the pink tinge of the porphyry.

Silver has been produced in Missouri for many decades as a by-product of lead production but has never been profitably mined for its value alone. At Silver Mine, on the west side of the river, the lead ore contains a relatively high content of silver. According to Hayes (1961, p. 20):

> *"Land in the Silver Mine area was entered as mineral land in 1855, and systematic prospecting began in 1877. Silver was obtained from argentiferous galena in the quartz veins. Approximately 50 tons of lead and 3,000 ounces of silver were produced up to the time of closing the mines which was about the middle 1880's. In 1916 tungsten was produced during the war years and again for a short time beginning in 1927."*

If at all possible, follow the footpath upstream from the parking area to the dam (fig. 31). The climb is gentle and the view is ample reward for the slight effort!

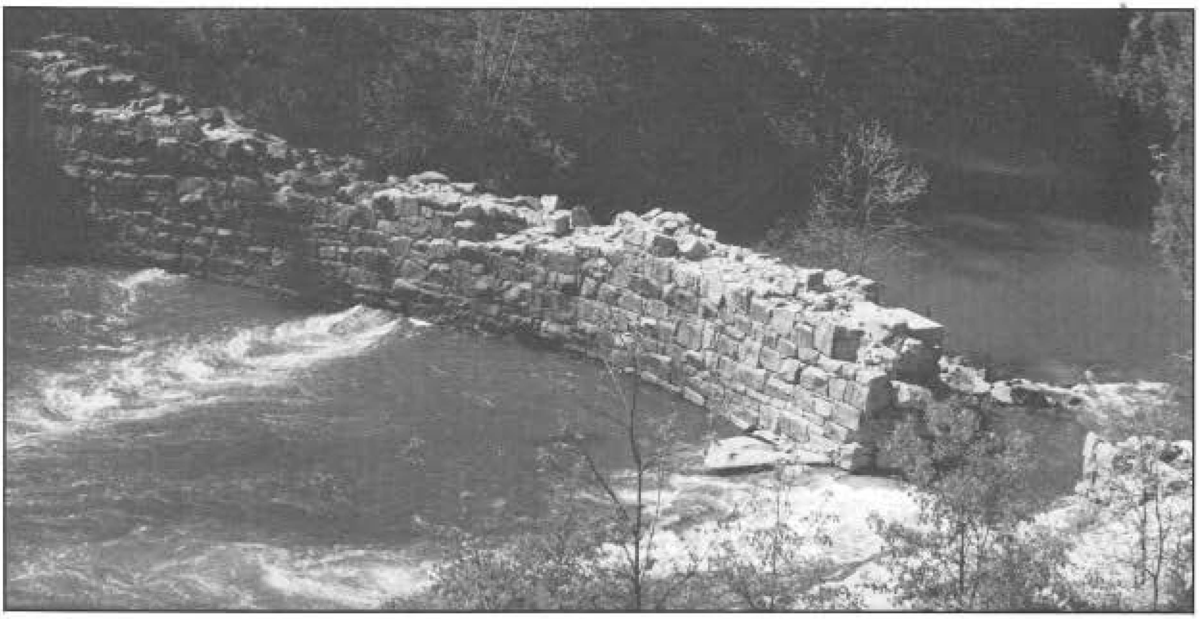


Figure 31

Dam at Silver Mines Shut-In in Madison County. Photo by Jerry D. Vineyard and James H. Williams.

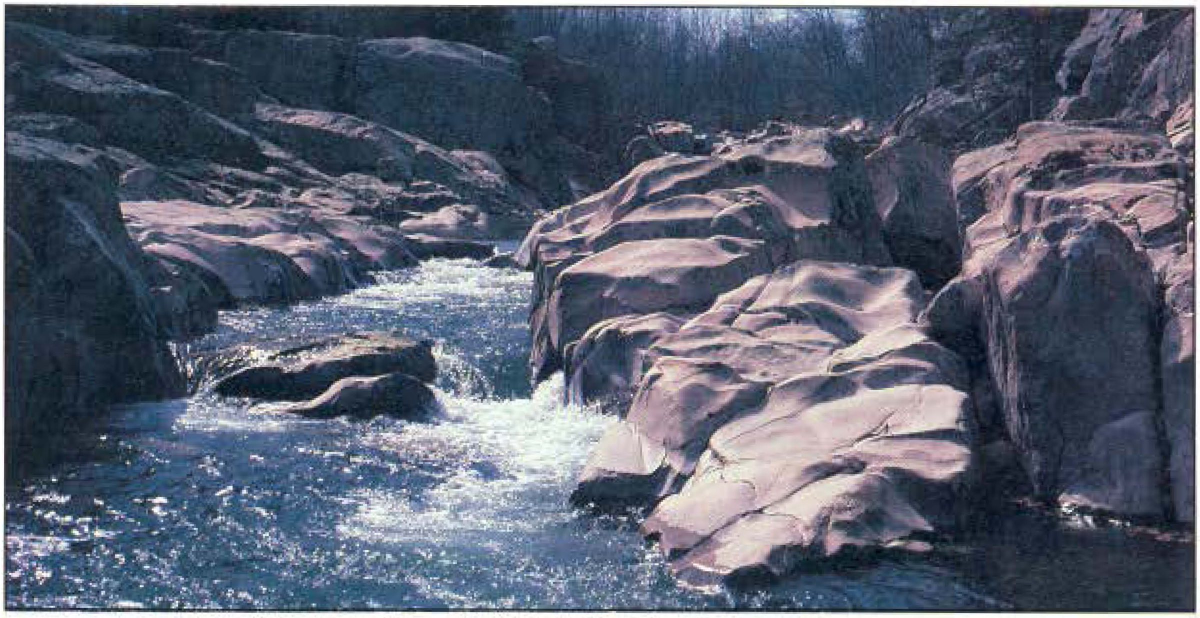


Figure 32

Pink granite, tall pines, and the clear waters of Castor River combine to make Hahns Mill Shut-In one of Missouri's most scenic places. Abrasion of the hard granite by sand and gravel moved by the stream during floods sculpts the angular shapes of the granite into smooth, rounded surfaces. Photo by Jerry D. Vineyard.

48. HAHNS MILL SHUT-IN (JDV)

Madison County, on Castor River, 8 miles east of Fredericktown, in NW¼ sec. 10, T. 33 N., R. 8 E., Higdon 7½-minute Quadrangle.

Hahns Mill Shut-In (fig. 32), surely one of the most beautiful of its kind in all Missouri, is noted on signs by its official name, Amidon Memorial State Forest. The property was acquired by the Missouri Department of Conservation in 1984, and is now managed to protect its natural qualities while allowing enjoyment of its beauty and its popularity as a place for swimming and sunbathing.

This is the only shut-in on Castor River. Its local name is "Pink Rocks," because the granite appears pink or grayish-pink. As in most similar shut-ins, the river smooths and polishes the rock near and several feet above river level, where flood-flows reach, and the higher elevations are affected by freeze-thaw, lichen growth, and other weathering factors that form a rugged, angular topography.

Castor River approaches Hahns Mill Shut-In from the northwest, passing between two oval-shaped hills at the head of the shut-in. Then, the river makes a sharp right-angle turn and heads south-southwest through the narrowest part of the defile. It is as if the river consciously made a flank attack on a granite knob, failed, and was forced to cut a canyon through just the edge of an igneous rock ridge.

49. STONO MOUNTAIN SHUT-INS

St. Francois County, 4 miles east of Iron Mountain (city), south-draining intermittent stream on southwest flank of Stono Mountain, near center S½ sec. 26, T. 35 N., R. 4 E., Iron Mountain Lake 7½-minute Quadrangle.

Karel and Elder (1975, p. 122) list this shut-in but do not describe it other than to say the stream flows only in wet months and *"In this 80 acres, the drainage drops 260 feet..."*

50. SHUT-IN MOUNTAIN	Shannon County, 8 miles southeast of Eminence and 0.5 mile east of Highway H, in NW¼ NE¼ sec. 11, T. 28 N, R. 3 W., on Stegall Mountain 7½-minute Quadrangle.	Requires 0.5-mile hike down Little Rocky Creek from Highway H.
51. BUZZARD MOUNTAIN SHUT-IN	Shannon County, 10 miles southeast of Eminence on Rocky Creek, in SE¼ SE¼ sec. 6, T. 28 N., R. 2 W., Stegall Mountain 7½-minute Quadrangle.	Near end of private road 0.25 mile north of Highway NN.
52. MILL MOUNTAIN SHUT-IN	Shannon County, 10 miles southeast of Eminence on Rocky Creek, in northwest corner sec. 5, T. 28 N., R. 2 W., Powder Mill Ferry 7½-minute Quadrangle.	At site of old mill near east end of Highway NN. On road which was impassable when visited in wet weather.
53. THORNY CREEK SHUT-IN	Shannon County, 13 miles southeast of Eminence on Thorny Creek, in northwest corner sec. 2, T. 28 N., R. 2 W., Powder Mill Ferry 7½-minute Quadrangle.	Would require a considerable hike. Best access by walking upstream from creek junction with Current River.
54. COUNCIL BLUFF SHUT-IN	Iron County, 5 miles southwest of Belgrade, in center NW¼ sec. 23, T. 35 N., R. 1 E., on Big River, Johnson Mountain 7½-minute Quadrangle.	Council Bluff Dam and reservoir floods most of shut-in.
55. ENOUGH SHUT-IN	Iron County, 1.5 miles southeast of Council Bluff Dam, in SE¼ SE¼ sec. 26, T. 35 N., R. 1 E., Johnson Mountain 7½-minute Quadrangle.	Photo in Dake (1930); Plate IV-B shows waterfall over porphyry.
56. SALINE CREEK SHUT-IN	Washington County, in S½ sec. 18, T. 35 N., R. 3 E., on Saline Creek, Banner 7½-minute Quadrangle.	Listed by Dake (1930, p. 24).
57. PEORIA SHUT-IN	Washington County, unnamed creek, in NE¼ sec. 13, T. 35 N., R. 1 E., Johnson Mountain 7½-minute Quadrangle.	Listed by Dake (1930, p. 25).
58. MOUNTAINVILLE SHUT-IN	Iron County, *"at Mountainville Store, on Big River...,"* in SE¼ sec. 22, T. 35 N., R. 1 E., Johnson Mountain 7½-minute Quadrangle.	Listed by Dake (1930, p. 25). Now flooded by Council Bluff Reservoir.
59. JAMES CREEK SHUT-IN	Washington County, *"just above the Hanson School, on James Creek...,"* in NW¼ sec. 17, T. 35 N., R. 2 E., Banner 7½-minute Quadrangle.	Listed by Dake (1930, p. 25).

60. CEDAR CREEK SHUT-IN NO. 1	Washington County, "... *along Highway 21, in the NE¼ sec. 13, T. 35 N., R. 2 E.,*" Banner 7½-minute Quadrangle.	Listed by Dake (1930, p. 25).
61. KITCHELL HILL SHUT-IN	Washington County, "... *along the main road, northwest of Caledonia, at the* [SE] *corner of* [Sec.] 34, T. 36 *N., R. 2 E...*" Belgrade 7½-minute Quadrangle.	Listed by Dake (1930, p. 25). Dake's location, "SW corner of Sec. 35," is in error.
62. AKER-KITCHELL SHUT-IN	Washington County, "...*on the secondary road in the NE¼ sec. 3, T. 35 N., R. 2 E.,*" Belgrade 7½-minute Quadrangle.	Listed by Dake (1930, p. 25).
63. PADFIELD BRANCH SHUT-IN	Reynolds County, "...*in the* [SE¼] *NE¼ sec. 10, T. 33 N., R. 1 E.,*", Edgehill 7½-minute Quadrangle.	Listed by Dake (1930, p. 25).
64. JAMES CREEK TRIBUTARY SHUT-IN	Iron County, "...*in the SE¼ SW¼ sec. 19, T. 35 N., R. 2 E.,*" Banner 7½-minute Quadrangle.	Listed by Dake (1930, p. 25).
65. CUB CREEK SHUT-IN	Iron County, "...*in the NE¼ SW¼ sec. 24, T. 35 N., R. 1 W.,*" Johnson Mountain 7½-minute Quadrangle.	Listed by Dake (1930, p. 25).
66. MUNGER SHUT-IN	Iron County, "...*on the East Fork of Black River, in the* [SW¼] *SE¼ sec. 35, T. 34 N., R. 2 E.*" (on Highway N, enroute to Johnson Shut-Ins State Park), Johnson Shut-Ins 7½-minute Quadrangle.	Listed by Dake (1930, p. 25).
67. CEDAR CREEK SHUT-IN NO. 2	Washington County, along Highway 21 where it crosses Cedar Creek, in the SW¼ sec. 18, T. 35 N., R. 3 E., Banner 7½-minute Quadrangle.	The most beautiful part, according to Dake (1930, p. 24), is "200-300 yards east of the highway, down the creek."
68. OTTERY CREEK SHUT-IN	Reynolds County, 0.75 miles east of junction Highways 49 and E, near east-central part of sec. 3 (long section), T. 33 N., R. 1 E., Edgehill 7½-minute Quadrangle (fig. 33).	Described as "striking" by Dake (1930, p. 24).
69. SHUT-IN CREEK	Iron County, 6 miles north of Johnson Shut-Ins State Park, in SE¼ sec. 30, T. 34 N., R. 2 E., Johnson Shut-Ins and Banner 7½-minute Quadrangles.	Reported to be one of the most impressive in the state. Jeep trail in very rugged country. Reached off north end of Highway MM north of Johnson Shut-Ins.

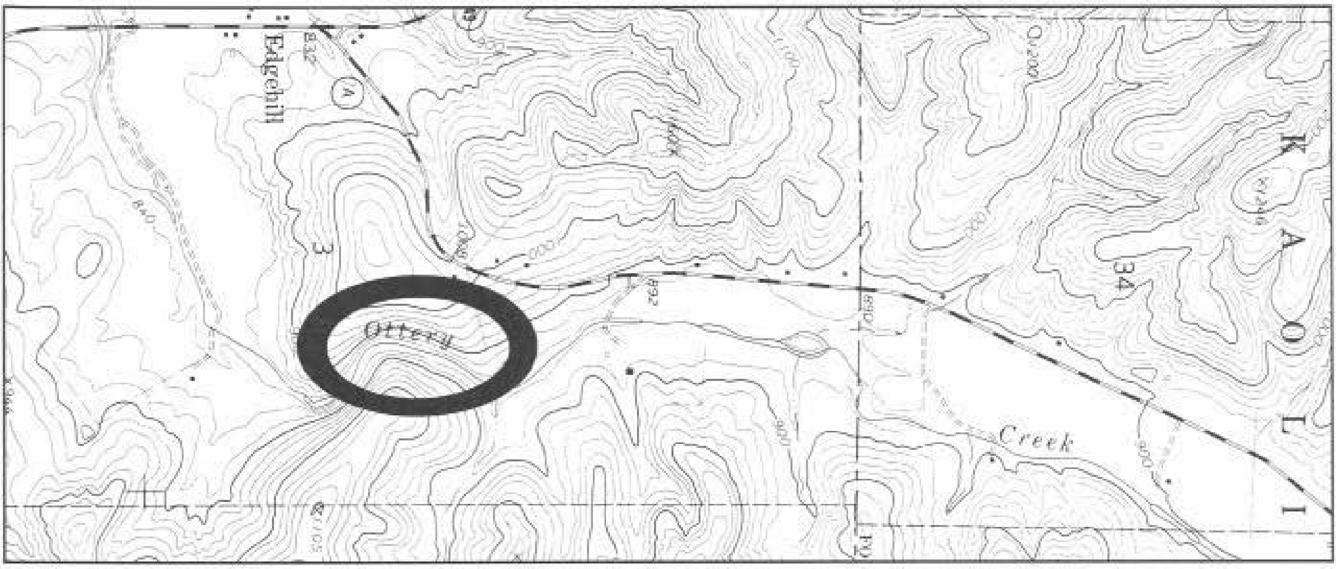


Figure 33

The shut-in of Ottery Creek is classic with broad valleys upstream and downstream, and a narrow "shut-in" area between. Topography from U.S. Geological Survey Edgehill 7½-minute Quadrangle. (The shut-in is the area below the word "Ottery"; map north is to the right.)

70. ROCK CREEK SHUT-IN

Madison County, 9 miles southeast of Ironton on Rock Creek, in sec. 33, T. 33 N., R. 5 E., Lake Killarney, Rhodes Mountain, Rock Pile Mountain, and Des Arc NE 7½-minute Quadrangles.

This feature is part of the Cathedral Canyon area described on p. 13-14; the map on p. 14 shows several shut-ins in sec. 33.

71. WEISS SHUT-IN

Madison County, 6 miles southeast of Ironton, on road extending east from Highway D enroute to Blue Mountain Camp, in sec. 17, T. 33 N., R. 5 E., Lake Killarney 7½-minute Quadrangle.

Was not particularly impressive from road during time of heavy summer foliage. Reported to have wild azaleas.

72. ROYAL GORGE

Iron County, 4 miles southwest of Arcadia, on Highways 21 and 72 or 1.7 miles south of Highway CC junction, near center common lines of secs. 14 and 23, T. 33 N., R. 3 E., Ironton 7½-minute Quadrangle.

Very scenic, but driver is too busy to enjoy it! Developed in the namesake Royal Gorge Rhyolite.

73. MARBLE CREEK SHUT-IN

Madison County, 15 miles southeast of Ironton and 20 miles southwest of Fredericktown, on north side of Highway E, on Marble Creek, in south-central part sec. 18 and north-central part sec. 19, T. 32 N., R. 5 E., Des Arc NE 7½-minute Quadrangle.

Attractive and photogenic eroded porphyry. Excellent facilities for picnicking, wading, and camping; U.S. Forest Service Recreation Area.

74. THE NARROWS	Madison County, 2 miles west of Fredericktown, on Little St. Francis River in secs. 13 and 14, T. 33 N., R. 6 E., Fredericktown 7½-minute Quadrangle.	Must be reached by floating or hiking. Between Mount Devon and Buckner Mountain.
75. PINNACLE SHUT-INS	Madison County, at The Pinnacles on Little St. Francis River.	See No. 119 "The Pinnacles."
76. BIG CREEK SHUT-INS	Wayne County, on Big Creek, in Sam A. Baker State Park, in SW¼ sec. 7, and N½ sec. 18, T. 30 N., R. 5 E., Brunot 7½-minute Quadrangle (fig. 34).	Lower part accessible from Park area.

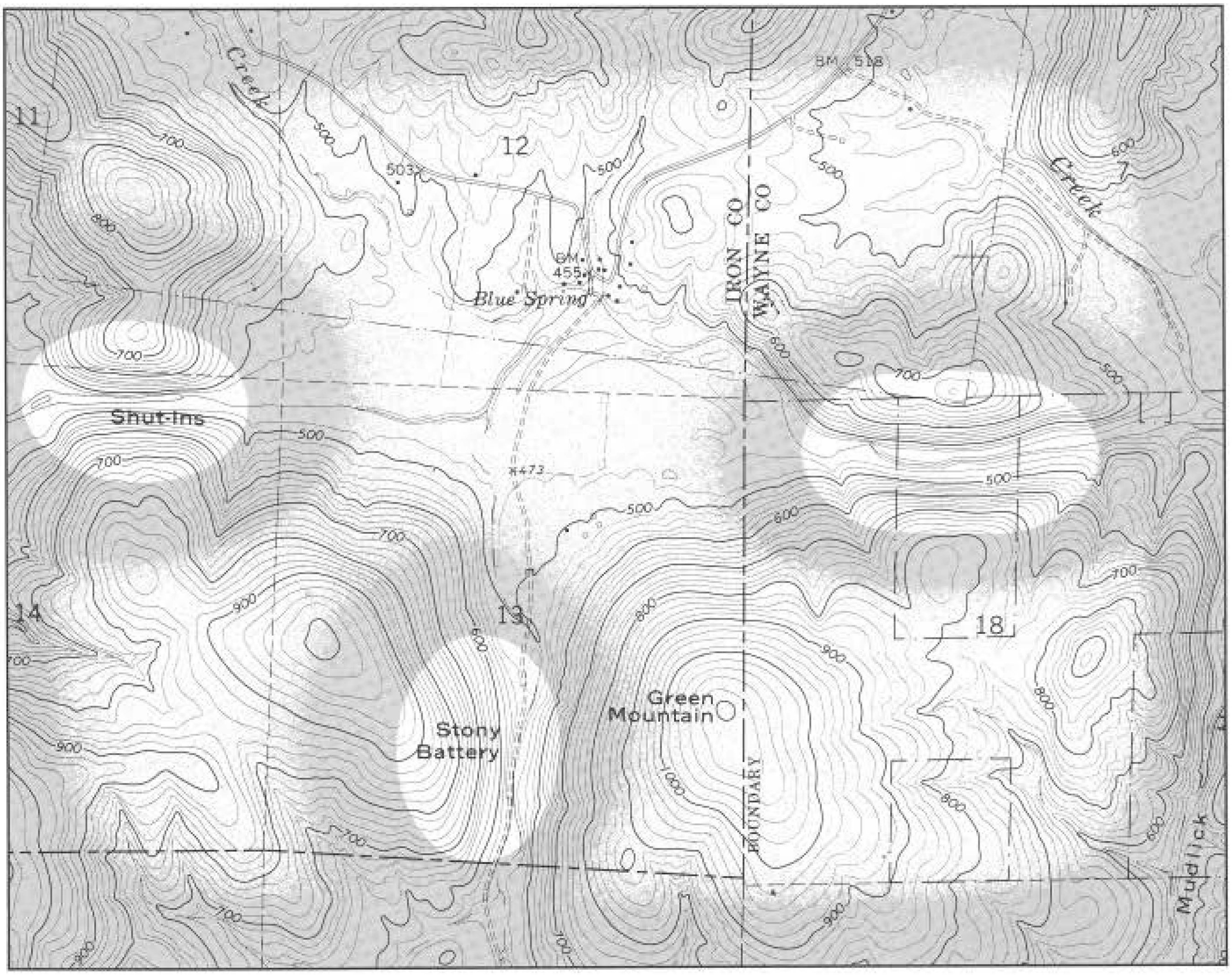
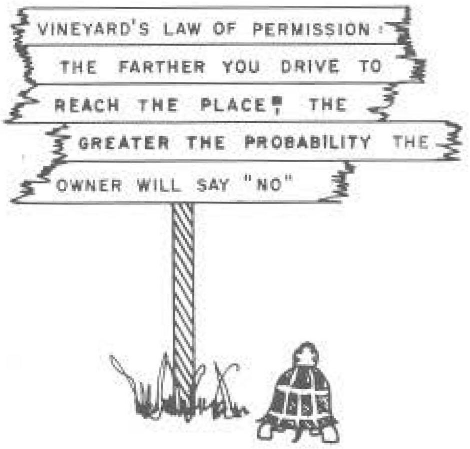

Creek
11
12
503
500
BM 518
700
800
BM 455
Blue Spring
IRON CO
WAYNE CO
Shut-Ins
473
600
Creek
13
14
18
900
Stony Battery
Green Mountain
1000
BOUNDARY
Mudlick

Figure 34

Unique triple shut-ins (No. 76) along Big Creek and its tributary near Sam A. Baker State Park separate knobs of ancient crystalline rocks in the St. Francois Mountains. Topography from U.S. Geological Survey Brunot 7½-minute Quadrangle.

77. BIG CREEK SHUT-INS	Iron County, 1.5 miles upstream from Sam A. Baker Park in N½ NE¼ sec. 14, T. 30 N., R. 4 E., Brunot 7½-minute Quadrangle (fig. 34).	Requires hiking. Reach via Highway N, southwest of Brunot.
78. STONY BATTERY	Wayne County, 0.5 mile west of Sam A. Baker State Park, in S½ sec. 13, T. 30 N., R. 4 E., Brunot 7½-minute Quadrangle (fig. 34).	Beyond terminus of Highway N north of Patterson. Road through is not all-weather.
79. CRANE SHUT-IN	Iron County, 2 miles north of Minimum or 5 miles east of Glover, in N½ sec. 3, T. 31 N., R. 4 E., Des Arc NE 7½-minute Quadrangle.	Requires 0.25-mile walk west from road crossing Crane Pond 2 miles north of Minimum. Reported to be very scenic.
80. PRAIRIE HOLLOW CANYON	Shannon County, 6 miles northeast of Eminence, in NW¼ SW¼ sec. 15, T. 29 N., R. 3 W., in Praire Hollow, Eminence 7½-minute Quadrangle.	An exceptionally scenic canyon with waterfalls in porphyry 0.25 mile east of Highway V. This canyon is unique in containing a cave and a small natural arch, features which are more at home in sedimentary rocks than in igneous ones such as porphyry. The cave is in the west wall of the canyon, opposite a westward-draining tributary in S½ NW¼ SW¼ and the arch is in the east wall, a few yards downstream from the tributary junction.
81. MATTHEWS BRANCH SHUT-IN	Shannon County, 7 miles northeast of Eminence, in SE¼ SW¼ sec. 10, T. 29 N., R. 3 W., at base of dam on Matthews Branch, on Eminence 7½-minute Quadrangle.	Accessible by private road.
82. LICK LOG HOLLOW SHUT-IN	Shannon County, 2 miles northeast of Eminence, in center NW¼ sec. 24, T. 29 N., R. 4 W., near junction of Lick Log Hollow and Jacks Fork, Eminence 7½-minute Quadrangle.	Accessible by trail or from Current River.
83. DURAND SHUT-IN	Madison County, on Marble Creek, 2 miles downstream (southeast) from Marble Creek Recreation Area, in NW¼ SW¼ sec. 21, T. 32 N., R. 5 E., Des Arc NE 7½-minute Quadrangle.	Accessible by jeep trail.

84. LITTLE ROCK CREEK SHUT-IN	Madison County, 15 miles southwest of Fredericktown on Highway E, 4.3 miles southwest from bridge over St. Francis River, upstream from French Mills, in E½ sec. 16, T. 32 N., R. 5 E., Rock Pile Mountain 7½-minute Quadrangle.	Drop of about 80 feet in 0.5 mile. Best seen during time of least foliage from Highway E which parallels it.
85. BLACK MOUNTAIN SHUT-IN	Madison County, 14 miles southwest of Fredericktown on Highway E, along St. Francis River, 3 miles southwest of Highway E bridge over this river, in secs. 10 and 15, T. 32 N., R. 5 E., Rock Pile Mountain 7½-minute Quadrangle.	Nearly a mile long. Best visited when foliage is minimal. Scenic cascades, jointed porphyry.
86. SHUT-IN CREEK	Miller County, at west edge of Tuscumbia, in secs. 4, 9, and 10, T. 40 N., R. 14 W., on Tuscumbia 7½-minute Quadrangle.	Most westerly known use of name "Shut-In" in Missouri. Constriction in valley of stream flowing on sedimentary rock (Gasconade Dolomite).
87. SHUT-IN HOLLOW	Ripley County, 16 miles northwest of Doniphan, tributary to Little Barren Creek, in secs. 1 and 2, T. 24 N., R. 1 W., Handy 7½-minute Quadrangle.	In sedimentary rock (Roubidoux Formation per *Geologic Map of Missouri*). Reported to be Bald Eagle nesting area. Requires hiking from Forest Service Road.
88. ROCK PILE MOUNTAIN SHUT-IN	Madison County.	See No. 130.



COUSINS TO SHUT-INS

89. CHAIN-OF-ROCKS (ST. LOUIS)

During, and possibly before the Pleistocene (Ice Age) the ancestral Mississippi River cut a huge valley in bedrock which was subsequently filled with alluvial clay, silt, sand, and gravel. The present-day river flows on this thick fill over much of its reach, with the exception of several stretches in the upper Mississippi River valley where glacial activity forced it to flow on bedrock (fig. 35). Navigation can be a problem at such places as exemplified at the Chain-of-Rocks portion downstream from the I-270 bridge. This problem was solved by construction of the Chain-of-Rocks canal but, in other areas upstream, a shallow bedrock valley has necessitated lock and dam installations.

The ancient channel, cut deeply into the bedrock, is from 4 to 6 miles east of the Chain-of-Rocks. Whereas the elevation of rocks at the Chain is about 385 feet above sea level, rock elevation in the ancient channel bottom is as low as 255 feet above sea level (Beveridge, 1976). The 10-mile-wide valley gives no surface hint of this ancient channel; it is mapped from bore holes and other data.

According to Hyde and Conrad (1899, p. 341), earlier attempts to make the rocky stretch navigable were a failure:

> *"In 1868 City engineer Homer erected a dyke from the Chain of Rocks, extending it out 1,600 feet. He then planned a dyke at an angle from the former one to cross the bend to the head of Cabaret Island, which was designed to throw the channel on the east side of the island. After expending $60,000, the city abandoned the scheme."*

90. CHAIN-OF-ROCKS (LINCOLN COUNTY)

Missouri has another Chain-of-Rocks, a community on the Cuivre River between Moscow Mills and Old Monroe on the northwest side of the river near the common corners of secs. 16, 17, 20, and 21, T. 48 N., R. 2 E., Lincoln County. At this point the riverbed is partly rocky, suggesting that it has wandered from an alluvium-filled valley and that its channel crosses a bedrock high.

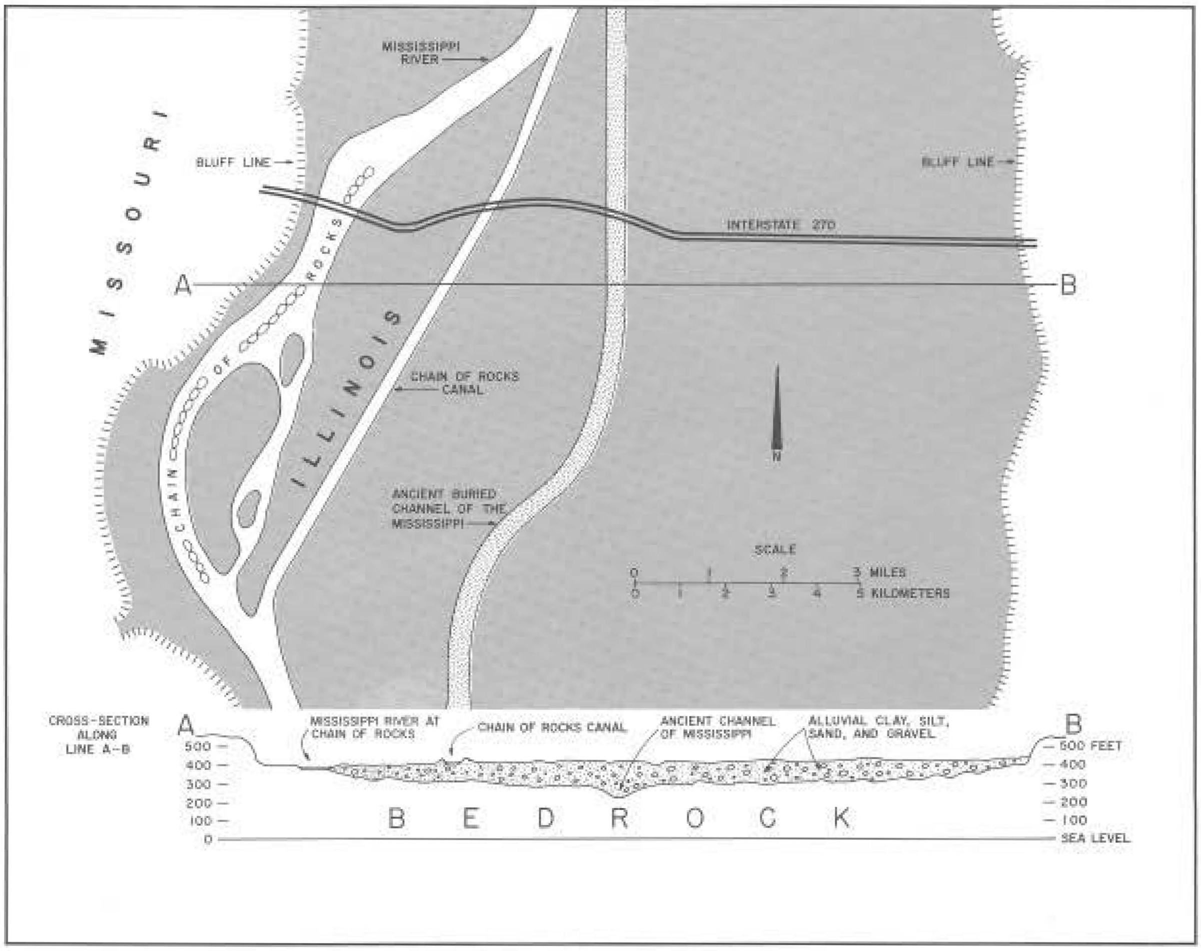

MISSISSIPPI RIVER
BLUFF LINE
BLUFF LINE
MISSOURI
CHAIN OF ROCKS
ILLINOIS
INTERSTATE 270
A
B
CHAIN OF ROCKS CANAL
ANCIENT BURIED CHANNEL OF THE MISSISSIPPI
N
SCALE
0 1 2 3 MILES
0 1 2 3 4 5 KILOMETERS
CROSS-SECTION ALONG LINE A-B
A
B
MISSISSIPPI RIVER AT CHAIN OF ROCKS
CHAIN OF ROCKS CANAL
ANCIENT CHANNEL OF MISSISSIPPI
ALLUVIAL CLAY, SILT, SAND, AND GRAVEL
500
400
300
200
100
0
500 FEET
400
300
200
100
SEA LEVEL
BEDROCK

Figure 35

Channel-bedrock relationships in Chain-of-Rocks (St. Louis) area.

91. THEBES GAP

The Mississippi River valley tends to be wide where it flows on alluvial fill in an ancient valley and narrow where it flows on bedrock. An excellent example of the latter situation is at Thebes Gap (also called Commerce Gorge) which is a short distance downstream from Cape Girardeau in eastern Scott County and extends south to the town of Commerce. In this stretch, the valley is only about 0.75-mile wide as contrasted with floodplain widths of nearly 10 miles in the St. Louis area. As shown in figure 80, in the discussion of the Southeast Missouri Lowlands, this condition results from the fact that the Mississippi formerly flowed along the west edge of the Lowlands from Cape Girardeau to past Poplar Bluff. Its drainage altered within the last 2,000 years or so and it took a shortcut through the gorge area. The shortcut may have resulted from stream piracy of a much smaller stream in the Commerce area that may have eroded headward through the Benton Hills and Shawnee Hills until it penetrated the divide and left a tempting path for the Mississippi.

Bedrock in the channel, some of which is pinnacled and above low water level, led to the names Grand Chain and Little Chain in this stretch. The Mississippi River Commission Chart No. 103, prepared in 1880-1881, delin-

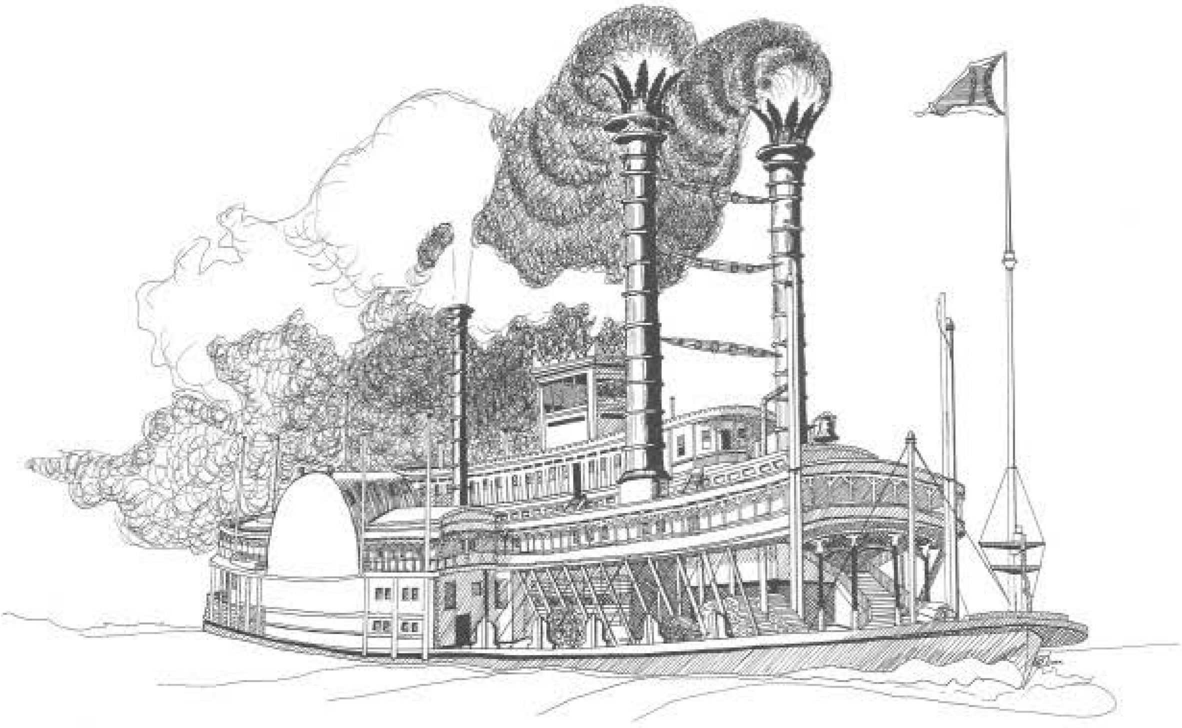


Figure 36

Mark Twain described navigational hazards on the Mississippi in the Thebes Gap area. Drawing by Susan C. Dunn.

eated these navigational hazards. The Grand Chain rock exposure is shown in the channel near the Missouri shore 0.75 mile below Thebes, and the upland landmark of the same name is atop the bluffs on the Missouri side opposite the south edge of Thebes, Illinois. Little Chain is shown on the Missouri side of the channel 0.9 mile above Commerce.

Mark Twain, in *Life on the Mississippi*, Chapter 25, describes this portion of the river:

"Thebes, at the head of the Grand Chain, and Commerce at the foot of it, were towns easily memorable, as they had not undergone conspicuous alteration. Nor the Chain, either — in the nature of things; for it is a chain of sunken rocks admirably arranged to capture and kill steamboats on bad nights. A good many steamboat corpses lie buried there, out of sight; among the rest my first friend, the Paul Jones; she knocked her bottom out, and went down like a pot, so the historian told me — Uncle Mumford. He said she had a gray mare aboard, and a preacher..."

Twain then continues to cite Mumford's and his own case histories of other disasters resulting from this allegedly unlucky passenger combination (fig. 36).

NORTH MISSOURI "SHUT-INS"

Outside of the classic shut-in area in the eastern Ozarks, Missouri has a number of stream valleys which are anomalous in having wide valleys which become exceptionally constricted downstream and then broaden again to their upstream width. Such valleys are common in northern Missouri where they have been cut in a contrasting variety of rock materials. Where cut in relatively hard sedimentary rocks, the valley is narrow. On the other hand, the valley may cross or reoccupy an ancient major stream valley cut in bedrock and subsequently be filled with easily eroded glacial clay, silt, sand, and gravel. Where the stream encounters this easily eroded material, it develops a broad valley as contrasted with the narrow valley in the more resistant rock upstream and/or downstream. A few examples of this common phenomenon follow.

92. GRAND RIVER "SHUT-INS"

a. Downstream, from 5 miles south of Albany, the valley is less than 0.125 mile wide as contrasted with a 2-mile width in the Darlington area to the north.

b. River is constricted 4 miles upstream from Pattonsburg and 5 miles downstream from Pattonsburg.

c. In the Gallatin vicinity, the valley is generally less than a mile wide whereas 4 miles southeast of Gallatin it is more than 3 miles wide.

93. THOMPSON RIVER "SHUT-INS"

a. At Trenton, the valley is 0.5 mile wide; upstream and downstream it is between 2 and 3 miles wide.

b. Nine-miles north of Chillicothe, the valley is more than 3 miles wide, but narrows to 1 mile wide, 6 miles north and also 4 miles northwest of Chillicothe.

94. NODAWAY RIVER "SHUT-INS"

a. Immediately south of Maitland, the valley is 3 miles wide; 1 mile north and 3 miles south of Maitland, it narrows to as little as 0.25 mile wide.

b. In northern Andrew County, it again broadens to a 3-mile width, only to constrict to less than 0.5 mile wide east of New Point.

95. ONE HUNDRED AND TWO RIVER "SHUT-INS"

a. In the vicinity of Maryville, the valley is 2 miles wide; at Arkoe, 6 miles to the south, it narrows to 0.25 mile wide.

b. Upstream from Barnard, the valley is less than 0.125 mile wide; downstream, between Barnard and Rosendale, it is more than 2 miles wide, but narrows to a hundred yards or less in width downstream from Rosendale.

Ramsay (1952, p. 9) states regarding the name of this river:

"A lucky find in the Kane Manuscripts of 1847, now preserved at Stanford University, proves that the puzzling One Hundred and Two River was merely an American rendering of the older French name Cent Deux, applied to an Indian village near its headquarters. That French name, as I have surmised by a perhaps too bold conjecture, was an adaptation by the early French traders of the Indian name Condse, meaning 'hillside forest'."

NATURE
WARNING!! This car stops at all bronze plaques!!!

4

Waterfalls and Rapids

All generalizations are false (if you will pardon the generalization). Regardless of the logic in this proclamation, generalization regarding the origin of waterfalls and rapids is dangerous. Most of the shut-ins have falls or rapids as part of their attraction, and in many of the sedimentary rocks, resistant ledges may result in falls as may fracture systems. In a few cases, as in No. 306, stream piracy produces falls.

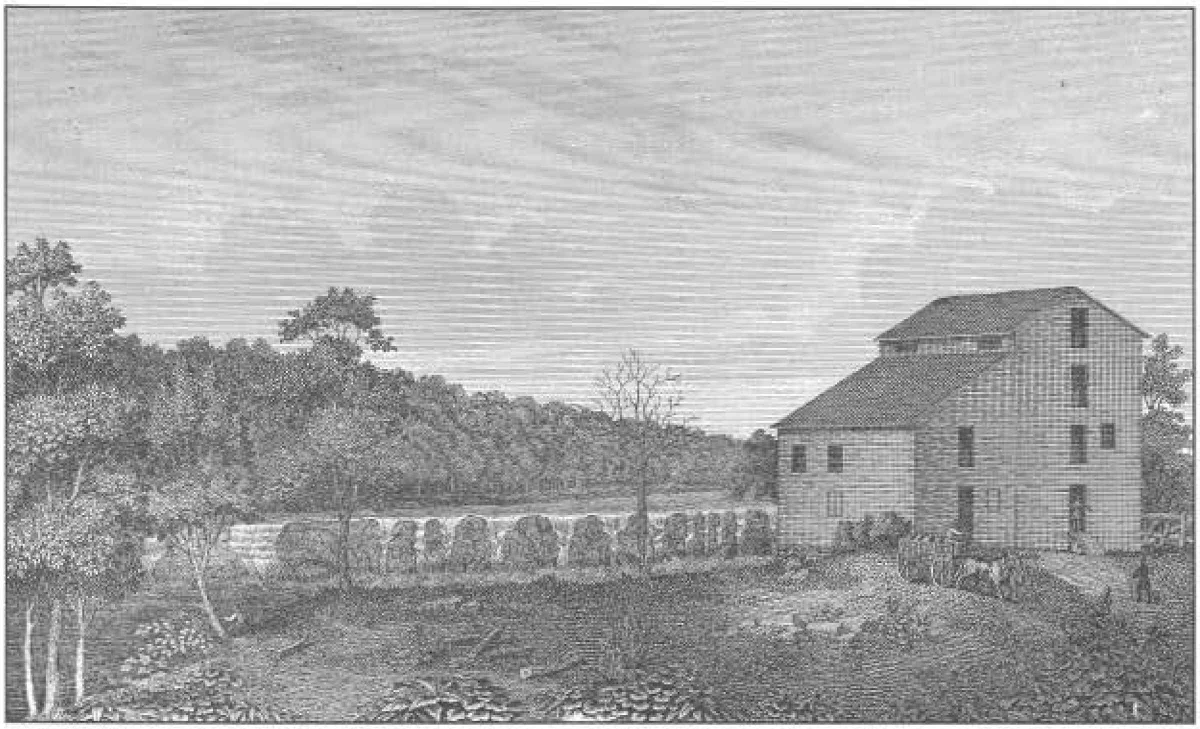


Figure 37

Grand Falls (the widest falls in Missouri) and Scott and Stewart's Mill on Shoal Creek in Newton County. The rock at the Falls is a chert bed of Mississippian age. From Swallow, 1855.

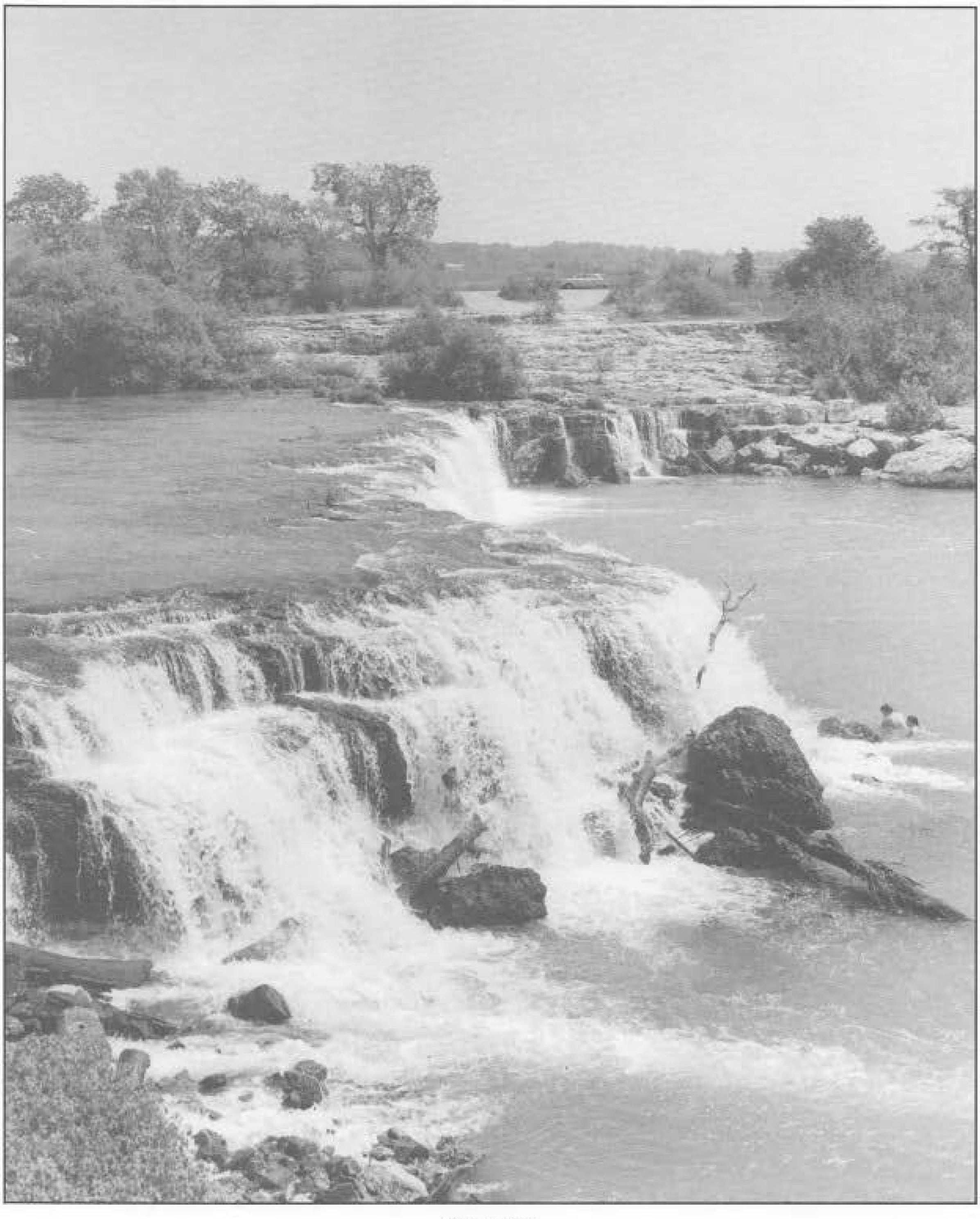


Figure 38

Despite its nearness to the City of Joplin, Grand Falls has not been significantly altered. Photo by Jerry D. Vineyard.

96. GRAND FALLS

Newton County, near south edge of Joplin on Shoal Creek, slightly south of center sec. 28, T. 27 N., R. 33 W., Joplin West 7½-minute Quadrangle.

Grand Falls holds first place in Missouri by having the greatest height of any continuously flowing falls inasmuch as nearly all of the state's falls are intermittent or ephemeral (flowing only after rainfall). Despite its nearness to a major city, Grand Falls has not been significantly changed by civilization. A low dam has had only a slight effect on profile and performance and the litter quotient is not excessively high (fig. 37).

These Falls are of interest to geologists because they represent an unusually thick outcrop (25 feet) of Mississippian chert. Because it is exceptionally resistant, this chert has formed a barrier to erosion and as Shoal Creek flows southward, it abruptly plunges 15 feet off this durable valley floor.

During high water, the height of Grand Falls increases to 25 feet, although the drop may not be continuous. This thicker section is on the left-hand (east) side of the stream where the chert forms stairsteps and benches, some of which are 5 feet thick, the thickness of individual chert beds. This natural spillway is used in times of high water, and its use has been sufficient during recent geologic history for the formation of some potholes, one of which is from 2 to 4 feet deep and 6 feet in diameter. Grand Falls can be photographed at almost any time of day (fig. 38).

The Falls and natural spillway beds of chert are best exposed and studied on the east side of the river; thus, they should be approached by driving along the south edge of Shoal Creek. From the junction of I-44 and Highway 86, go south 1.2 miles, cross Shoal Creek, and turn right (west) immediately after crossing the bridge. Then follow the drive along the south bank of Shoal Creek for an additional 3 miles, keeping an eye out to the right for the Falls. Two unmarked turnoffs from the road lead into a small parking area naturally paved by chert beds which need little maintenance.

97. FINLEY FALLS

Webster County, 3 miles southeast of Diggins or 4 miles southwest of Seymour on Finley Creek, near center NW¼ sec. 7, T. 28 N., R. 17 W., Seymour 7½-minute Quadrangle.

By virtue of its charm, drive-in accessibility, and proximity to Highway 60, Finley Falls (fig. 39) deserves more publicity (with its attendant drawbacks!) than it gets.

The Falls formed where Finley Creek crosses a resistant ledge of the Swan Creek Sandstone Member of the Cotter Dolomite. Erosion of dolomite beds above and below the tougher sandstone leaves this rock locally interrupting the topography as a low escarpment which paves the bed of Finley Creek to produce a natural low-water ford with the Falls forming the downstream edge of the "slab."

A prominent system of north-trending parallel vertical fractures (joints) has contributed to the charm of the Falls. As viewed from above, these fractures resulted in fingers of sandstone which produce a serrated fall face. Some of the larger fingers are 15 feet long, average 3 feet wide, and have been separated from the main mass of sandstone by erosion.

The Falls is 50 yards long and has a 7-foot-high face with an additional 3 feet extending to the bottom of plunge pools. The sandstone contains shallow potholes in addition to being grooved along joints. These features have the virtue of slowing traffic across the ford in addition to their esthetic merits. A faint hint of shut-in country is produced by the erosional carving of the sandstone, but the setting is of an open rather than constricted stream.

The spoor of the picnicker attests to Finley Falls' popularity but, in general, humans have been fairly kind to the site. Photography would be best at noon to minimize shadows in the sandstone finger system. Foliage is no problem, and there is the option of picnicking-wading in the summer or perhaps some attractive ice formations in the winter.

From the railroad track at Diggins, follow Highway NN south for 2.1 miles and turn left

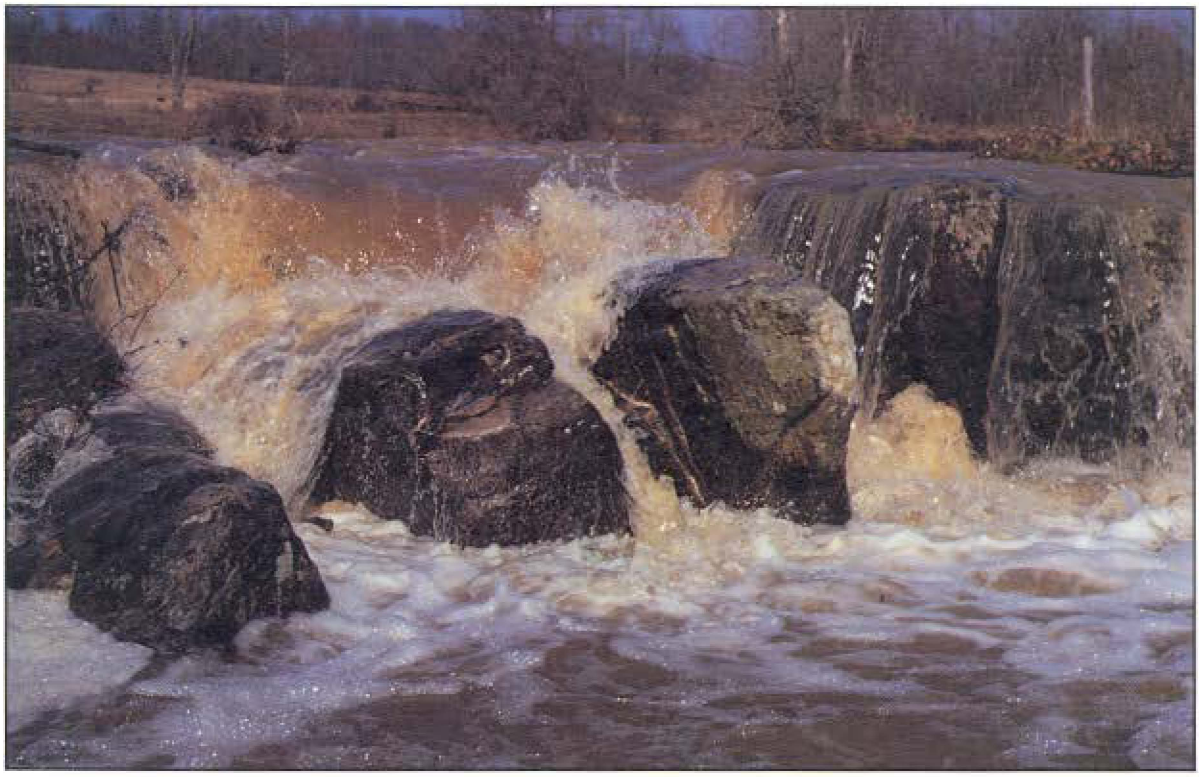


Figure 39

Finley Falls is 50 yards long and has a 7-foot-high face with an additional 3 feet extending to the bottom of plunge pools. Photo by Jerry D. Vineyard.

(east) onto a gravel road. Follow this road east for an additional 0.9 mile and then turn sharply to the right (south). The Falls are 0.2 mile south and you can't miss 'em!

98. FORT WOOD FALLS AND ARCHETTE

Pulaski County, south end of Fort Leonard Wood in firing impact area, in SE¼ NW¼ SE¼ NW¼ sec. 22, T. 34 N., R. 11 W., Bloodland 7½-minute Quadrangle.

The first attempt to visit this site was thwarted by heavy activity on the firing ranges. In keeping with the Biblical provision (Matthew 12:11 and Luke 14:5), it was visited on a Sunday when there was no firing. The visit justified the return and the lack of litter suggested that the site is not well known or that the timid turned back at the warning sign.

The site combines a wet-weather waterfall, the first stage of a small natural arch, and a budget-size canyon (fig. 40). All of the features result from erosion of sandstone of the Roubidoux Formation. Falls Hollow would be most photogenic after a heavy rain and there isn't much foliage. A morning visit would be appropriate because the falls face almost due east.

Water approaching the falls may take two routes. Part of it goes into a sump pit, 8 feet in diameter and 3 to 4 feet deep, about 12 feet upstream from the lip of the falls. The sump water drains through a small natural arch, about 1 foot high by 6 feet deep, under the lip of the falls. If the flow is too great for the sump drainage, excess water flows over the falls and plunges 18 feet into a pool garnished with huge sandstone blocks. Some of these blocks have excellent fossil ripple marks, attesting to the shallow water environment of the sea at the time the sandstone was deposited.

The falls, slot, overhang, and canyon are erosion-weathering phenomena. The sandstone is spalled and crumbled in the horizon of the thinner softer beds below the elevation of the lip of the falls. The re-entrant under the lip of the falls continues downstream for a short distance on the north side of the canyon and contributes to the craggy and primeval setting.

A few yards upstream from the sump pool, the sandstone in the streambed contains two large disc concretions a foot high and 4 to 5 feet in diameter. These were probably formed by a localized natural cementation of the sandstone which has made it resistant to erosion and weathering.

Fowke (1922, p. 56-57) refers to:

"...a group of house mounds, about 100 in number, close to the site of the Ranch House, which formerly stood near the Falls..." 4 miles southwest from Big Piney. These low mounds of uncertain origin are common in the Ozarks but were not searched for during a visitation in 1972. The "Ranch House" may refer to part of the Fidelity Horse Ranch of pre-Fort Leonard Wood days.

The site was reached by the following route:

Miles	
0.0	*Palace Church on Highway AW; go north on AW, which is old Highway 17 and becomes Iowa Avenue within the Fort.*
0.25	*Enter Fort Leonard Wood.*
0.85	*Turn right off blacktop onto gravel road.*
1.05	*Take left fork with due recognition of DANGER — IMPACT AREA sign.*
1.8	*Road crosses sandstone-bottomed ford.*
1.9	*Park and walk to right, south to the falls about 200 yards downstream from ford.*

NOTE: Do not attempt to enter this area when firing ranges are active. Sunday is the most probable day for serenity. The last mile of road was badly rutted in spots; it may not remain passable to passenger cars.

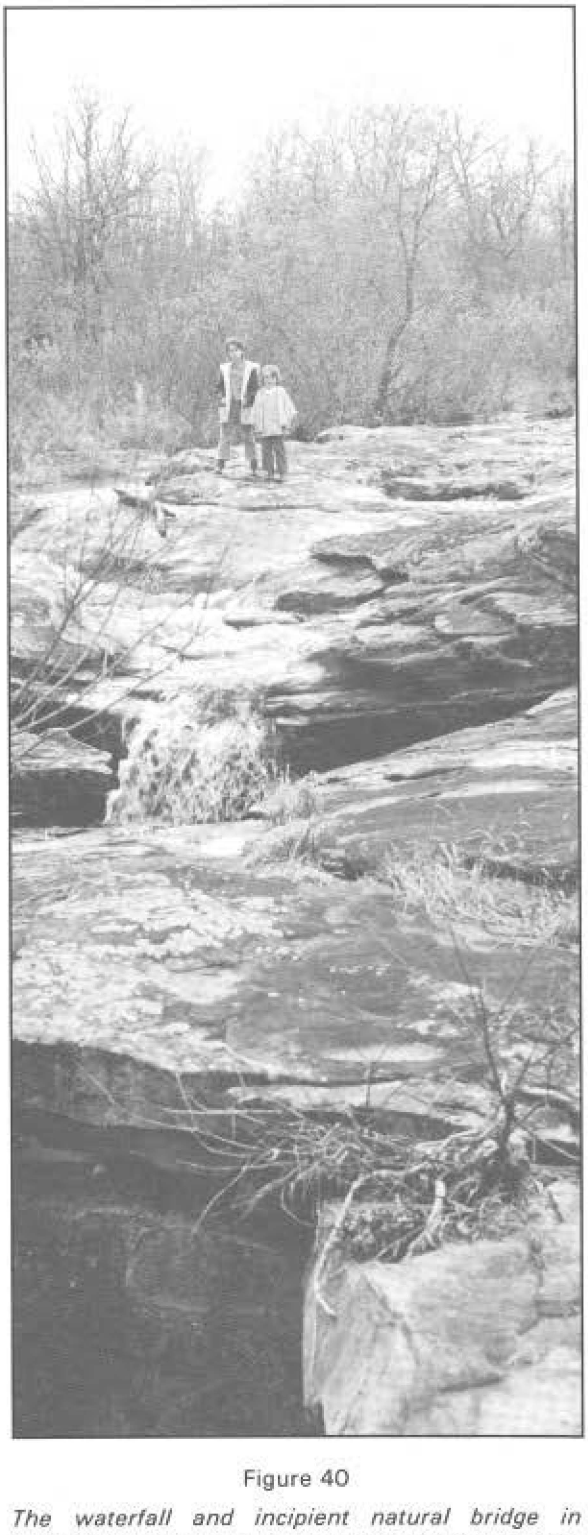


Figure 40

The waterfall and incipient natural bridge in Roubidoux sandstone at Fort Leonard Wood, Missouri. Photo by Jerry D. Vineyard.

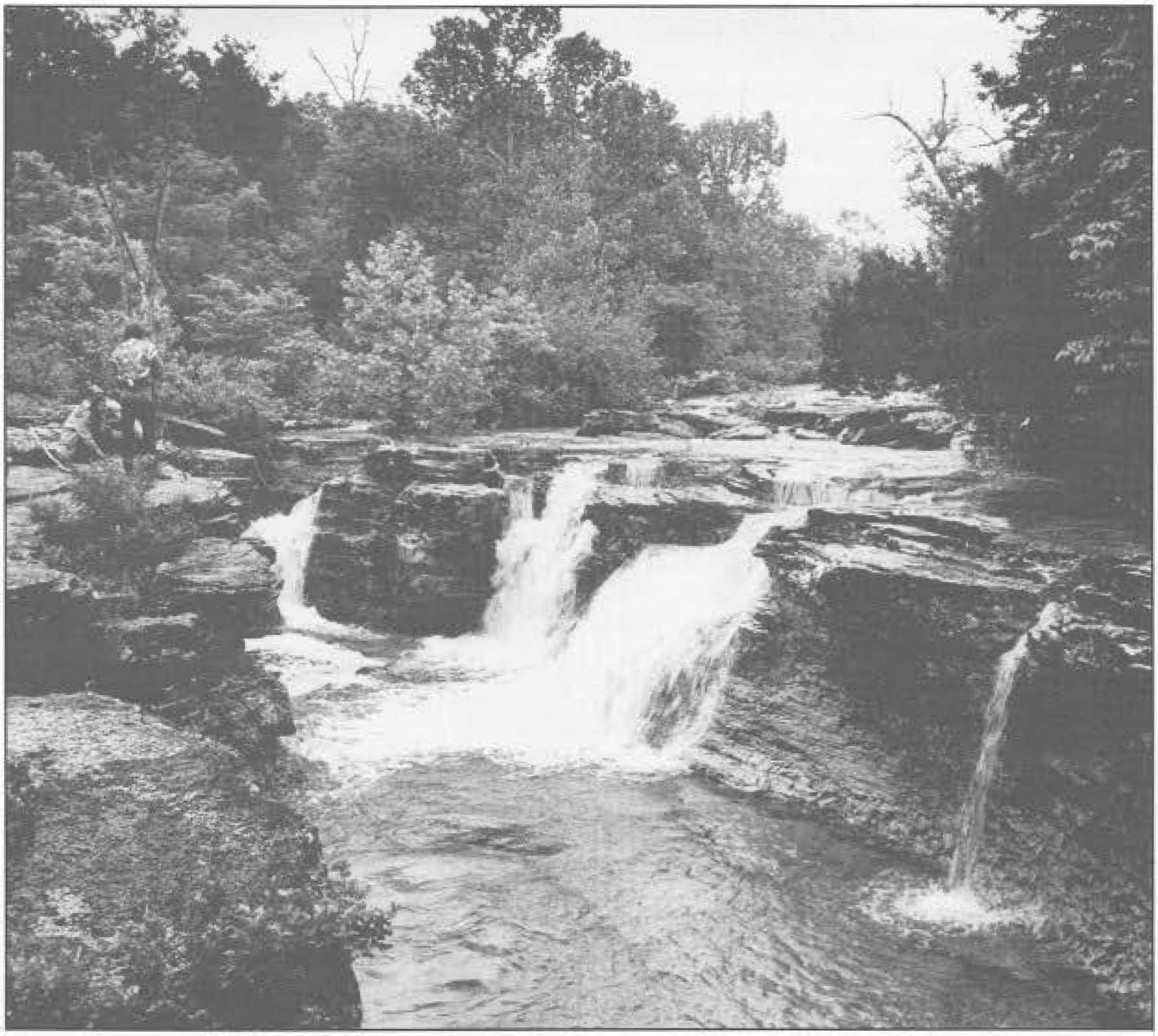


Figure 41

Upper falls of Long Creek in Taney County. Photo by Roger Pryor.

99. DEVILS DEN

Taney County, 7 miles southeast of Taneyville, on north side of Long Creek, in E½ sec. 8 and W½ sec. 9, T. 23 N., R. 18 W., and/or SW¼ SE¼ SE¼ sec. 9, T. 23 N., R. 18 W., Hilda 7½-minute Quadrangle.

Confusion reigns both on the location and nature of this Devils Den. The site was not visited but an article regarding it (Farmer, 1971) is so intriguing that it is on the list of Places-I-Must-See-When-I-Have-A-Whole-Day-To-Make-The-Visit. The area boasts a combination of highly pinnacled dolomite with waterfalls (fig. 41) and a topography reminiscent of the streambed sculpting in some of the shut-ins. Farmer describes it as:

> *"...a place of extraordinary beauty. The erosion of the ages has created interesting and unusual effects in the dolomite limestone, effects that would provide the photographer with hours of inspection and shutter snapping, or afford the amateur geologist much speculation as to time spans."*

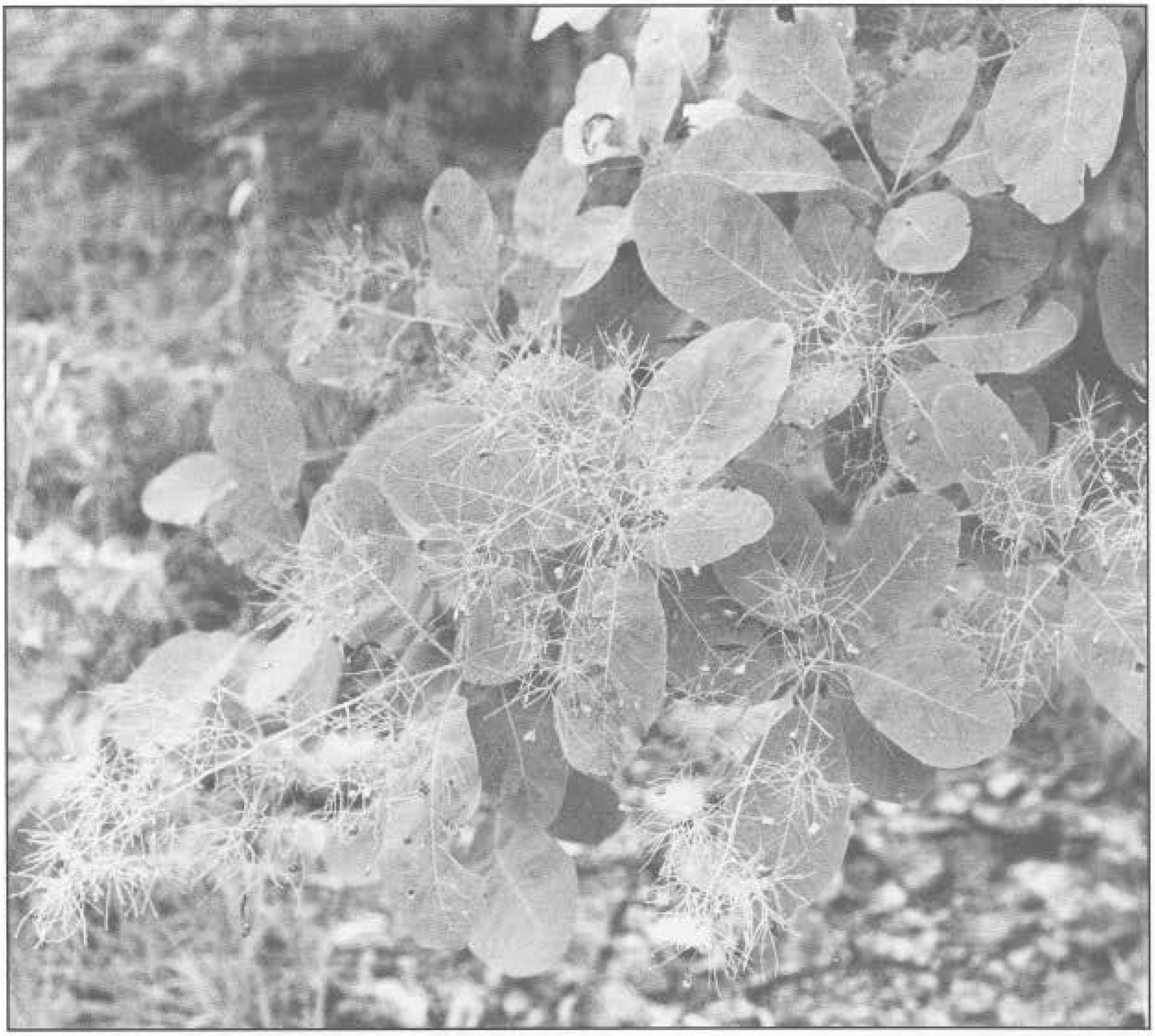


Figure 42

"Smoke tree" on Long Creek in Taney County. Photo by Roger Pryor.

He also describes it as:

> *"...a narrow chute in the riverbed perhaps 30 feet wide at the widest point, perhaps 100 yards long beginning to end, and with clear but shallow streams of water trickling toward Beaver Creek."*

His photographs show that environment is conducive to waterfalls at times of heavy rainfall, and it would appear that some of the pinnacles and accompanying falls may be from 10 to 15 feet high. The fractional section location is given on the basis of bunching of contour lines crossing the Devils Den tributary as shown on the topographic map.

However, the site Farmer so graphically described is on Long Creek in SW¼ SE¼ SE¼ sec. 9, while the Hilda Quadrangle shows Devils Den not as an isolated waterfall but as an entire hollow, tributary to Long Creek from the north. Farmer did not mention visiting the hollow, nor did Rhodes et al. (1974, p. 88-97), who devoted a chapter in the Time-Life series book, *The Ozarks* to Long Creek.

Since Farmer and Rhodes et al. visited the area, Congress has established the Hercules Glades Wilderness Area, and the Long Creek area is accessible by foot trail or horseback only. A permit is required from the U.S. Forest Service before entering the wilderness, but a day on Long Creek is an unforgettable experience (fig. 42). The trailhead at Hercules Lookout Tower south of Bradleyville is a convenient access point, and permits for day use only may be obtained there.

100. DEVILS DEN HOLLOW

Warren County, approximately 11 miles east of McKittrick, a tributary to Lost Creek, which, from its juncture with Lost Creek in NW¼ NE¼ NW¼ sec. 22, heads northeast in the southern part of secs. 15 and 14, T. 46 N., R. 3 W., Treloar 7½-minute Quadrangle.

An 1885 history of Warren County contains the following description of Devils Den (Cochrane, 1885, p. 963):

> *"On Lost Creek, in a sort of side canyon, called the Devils Den Hollow we find a sort of columnar structure, near the top. These columns are one to four feet long, perpendicular to the strata, and are from four inches to more than a foot in thickness."*

The same reference refers to the rock as being the Trenton Limestone which, by the modern nomenclature, probably is the Kimmswick. The columnar structures were not seen as the streambed was followed from its juncture with Lost Creek upstream for a mile. They may be high on the canyon walls in the lower part of the valley or near the streambed nearer the head.

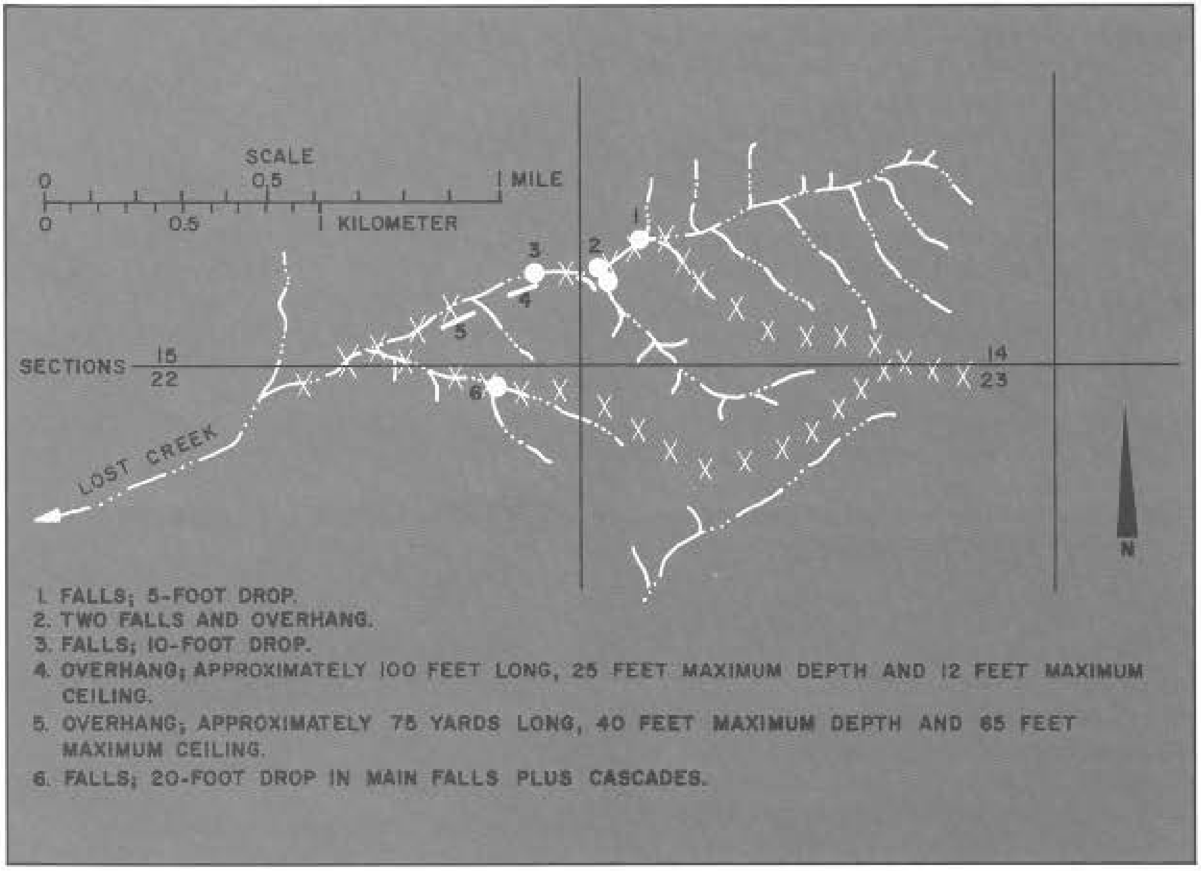

SCALE
0
0.5
1 MILE
0
0.5
1 KILOMETER
SECTIONS 15/22
14/23
LOST CREEK
N
1
2
3
4
5
6
1. FALLS; 5-FOOT DROP.
2. TWO FALLS AND OVERHANG.
3. FALLS; 10-FOOT DROP.
4. OVERHANG; APPROXIMATELY 100 FEET LONG, 25 FEET MAXIMUM DEPTH AND 12 FEET MAXIMUM CEILING.
5. OVERHANG; APPROXIMATELY 75 YARDS LONG, 40 FEET MAXIMUM DEPTH AND 65 FEET MAXIMUM CEILING.
6. FALLS; 20-FOOT DROP IN MAIN FALLS PLUS CASCADES.

Figure 43

Sketch map of Devils Den Hollow showing route traversed (X X X X X X) and features seen.

The visit was not a disappointment. Waterfalls and overhanging bluffs formed in St. Peter Sandstone and decorated with icicles in keeping with the spirit of late December produced a complete breakdown in photographic temperatures.

As shown in figure 43, Devils Den Hollow contains a minimum of five waterfalls and three shelters, a number which would probably be doubled if all tributaries were checked. Of streams flowing on sedimentary rock, Devils Den Hollow holds the record for concentration of waterfalls (fig. 44) among those visited in the state. A minimum of several hours should be allowed for exploring this stream. Hiking is not easy, but the area is a gem!

101. BENCHMARK WATERFALLS AND SHUT-IN (JDV)

Taney County, SW¼ NW¼ NE¼ sec. 6, T. 22 N., R. 20 W., at 910 benchmark, Hollister 7½-minute Quadrangle.

In section 6, there is a benchmark shown at elevation 910. This is on a concrete culvert carrying a tributary of Trigger Creek. When visited on November 20, 1974, this tributary was carrying water, although the topographic map shows it as an intermittent stream.

The base of the culvert rests on bedrock of the Jefferson City-Cotter dolomites, and just below the outlet of the culvert there is a 10-foot vertical waterfall dropping the stream into a shut-in-like valley with an impressive overhanging rock ledge, the whole thing extending for no more than 200 feet downstream. The stream drops rapidly, first over the 10-foot waterfall, then over a series of jumbled breakdown boulders giving an impression much like a shut-in in the igneous rock country of southeast Missouri.

102. ROUND BOTTOM WATERFALL

Hickory County, 3 miles south of north county line, near Pomme de Terre River, in S½ SW¼ sec. 22, T. 38 N., R. 22 W., Fristoe 7½-minute Quadrangle.

Musser (1975) describes a 14-foot waterfall at the head of a ravine near a 60-foot limestone (dolomite) bluff which "rims the western edge" of a north-facing steep slope. The slope area is described as undisturbed virgin woods.

103. CROWN CENTER HOTEL WATERFALL

Jackson County, in Kansas City at Crown Center, 25th and Main, east of Union Station, Kansas City 7½-minute Quadrangle.

The Crown Center Hotel Waterfall (fig. 45) is a five-story, indoor, all-weather creation complete with vegetation and devoid of ticks, chiggers, and poison ivy. Vineyard (1972, 1974a) describes the alternating Pennsylvanian limestones and shales of these interior gardens as being (from top to bottom) the Cement City Limestone, the Chanute Shale, Paola Limestone, Muncie Creek Shale, and the Raytown Limestone at the waterfall. The swimming pool starts in the Lane Shale and bottoms in the Raytown Limestone (fig. 46).

The nitpicker might argue that this is an artificial situation because of the excavation involved to create the waterfall as part of the hotel decor, but no one can argue that the water, limestone, and shale are not natural. Geology can be beautiful — and luxurious.

A GOOD GUEST
GETS INVITED BACK

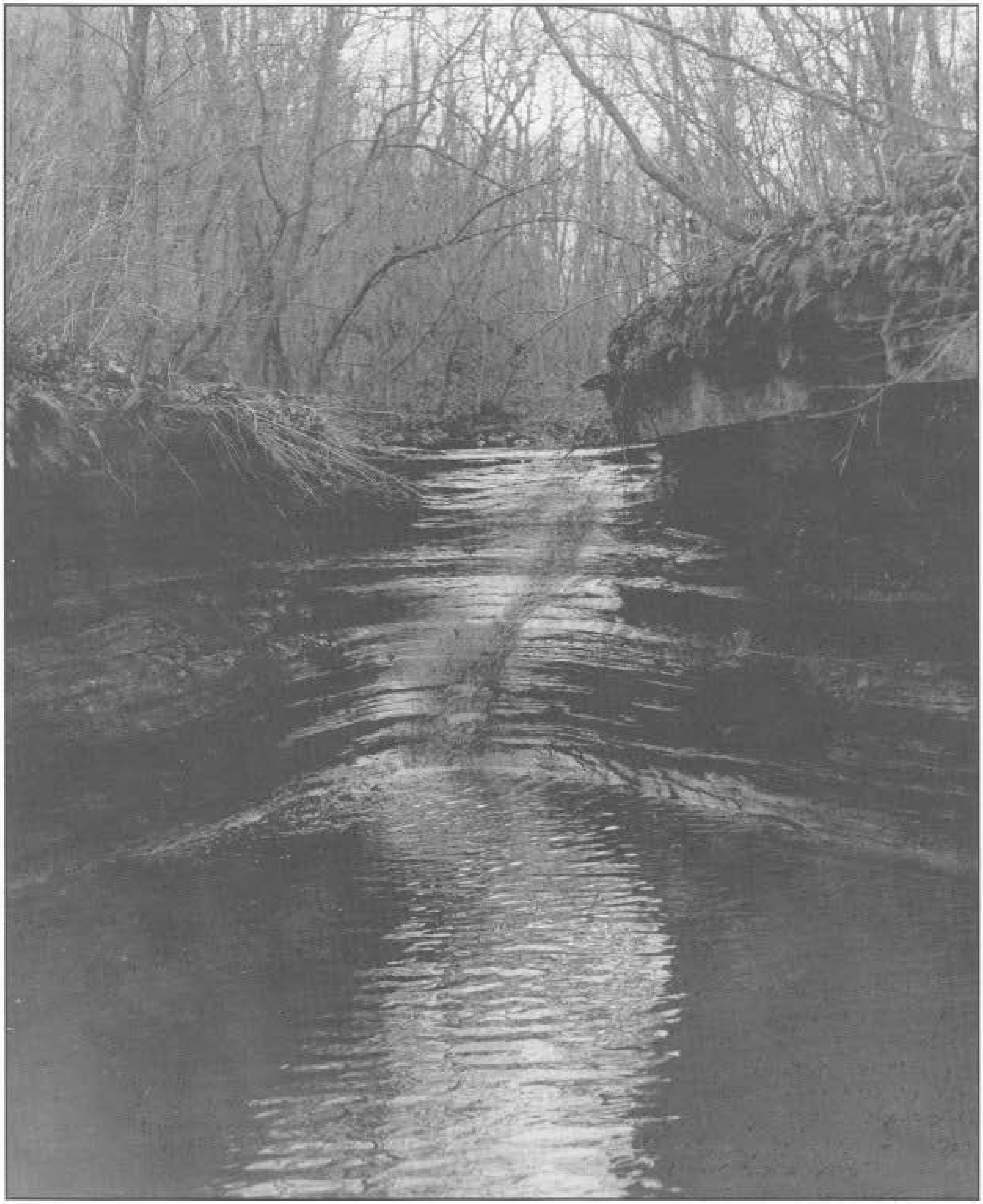


Figure 44

Waterfall in Devils Den Hollow, Warren County. Photo by Jerry D. Vineyard.

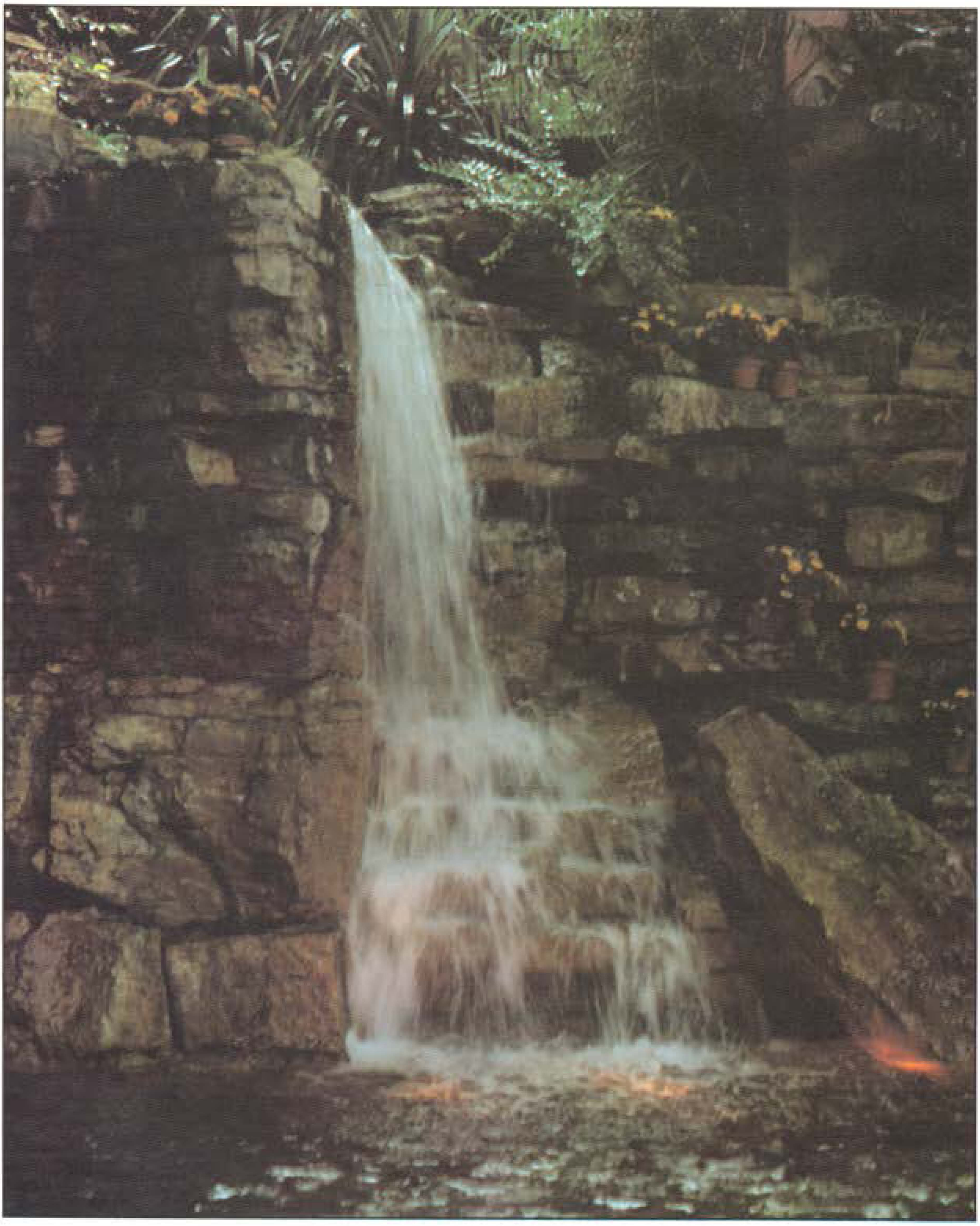


Figure 45

The Crown Center Hotel Waterfall. Photo by Connie Schmiedeskamp.

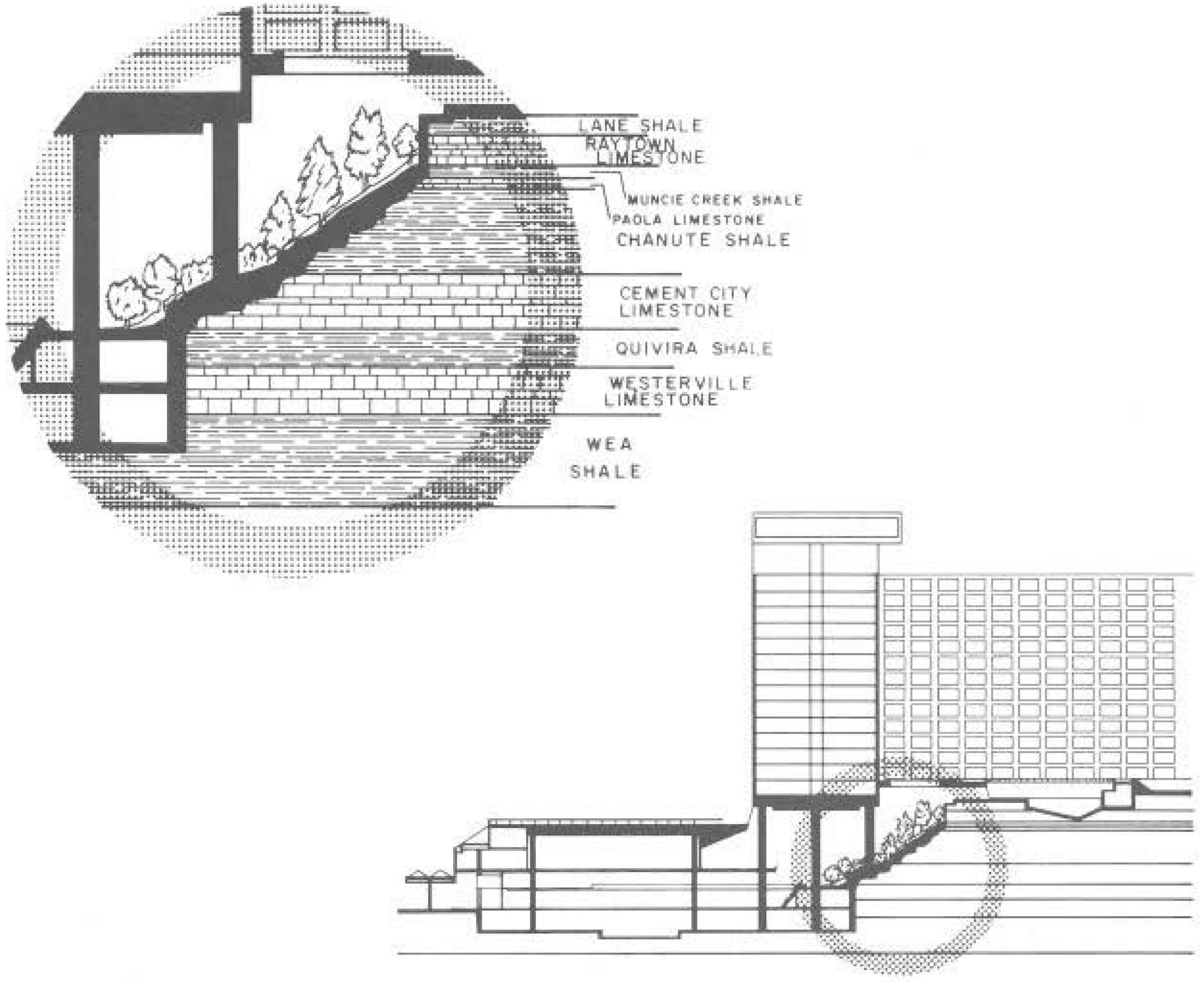

LANE SHALE
RAYTOWN LIMESTONE
MUNCIE CREEK SHALE
PAOLA LIMESTONE
CHANUTE SHALE
CEMENT CITY LIMESTONE
QUIVIRA SHALE
WESTERVILLE LIMESTONE
WEA SHALE

Figure 46

The Crown Center Hotel, at the north base of Kansas City's famed Signboard Hill, features a waterfall and garden in the lobby. The Hotel rests on Pennsylvanian strata of limestone and shale. Drawings from MISSOURI MINERAL NEWS, v. 14, n. 4 (April 1974), p. 57-58.

104. CATARACT HILL

Carter County, 6 miles southeast of Big Spring, Big Spring 7½-minute Quadrangle.

Cataract Hill is so named, not because of a cataract on its steep slopes, but because it flanks some very rough fast water in the Current River. The hill is named on the topographic map in secs. 14 and 23, T. 26 N., R. 1 E., but the cataracts in the Current are at the east foot of the hill in E½ NW¼ sec. 24, on the east side of Highway Z, 0.7 mile south of Kelley Cemetery. Although the water is impressive to those floating the stream, the amount of vertical fall is not sufficient to produce a waterfall.

Leonard Hall (1969, p. 219) describes this stretch as follows:

"A place well named is the Cataract, a mile-long run of swift and treacherous water where the skeletons of great sycamores washed down in the floods of many years have lodged to lie in wait for the unwary boatman."

105. THE FALLS

Ozark County, on North Fork White River, 4 miles east of Sycamore, in SE¼ SE¼ NE¼ NW¼ sec. 8, T. 23 N., R. 11 W., Cureall NW 7½-minute Quadrangle.

The Falls is shown on the Cureall NW Quadrangle as rapids in the river, but apparently does not represent a major waterfall, for Hawksley (1972, p. 89) says *"The Falls is merely a rock ledge about 2-3 feet high."* Probably the most impressive view of The Falls would be through the eyes of a neophyte canoeist with little freeboard.

106. MOSSTONE FALLS

(See also Elephant Walk, page 324).

Taney County, 3 miles west-northwest of Hercules Lookout Tower, in the Hercules Glades Wilderness of Mark Twain National Forest, on the Pilot Knob Trail, in NE¼ SW¼ NW¼ SW¼ sec. 3, T. 23 N., R. 18 W., Hilda 7½-minute Quadrangle.

Mosstone Falls is about a hundred yards north and downstream from Elephant Walk. The falls spill over a lip of massive Ordovician dolomite of the Jefferson City-Cotter formation, and free fall about 20 feet to a small plunge pool. During most of the year, the little stream is dry, but in early April when the serviceberry, or shadbush, is in bloom, and the redbud starts its spectacular color show, the 3-mile walk down Pilot Knob Trail is delightful; one can marvel at Elephant Walk and then take a rest at Mosstone Falls.

The name comes from massive deposits of "mosstone" formed in conjunction with the falls. Moss grows in damp places, and here the water, charged with gas and calcium carbonate from the dolomite, loses its gas (degases) and the calcium carbonate is precipitated within the moss, producing "mosstone." Two massive "pillars" of it, looking like stalagmitic deposits in caves, flank the falls.

MINA SAUK FALLS

Iron County

See feature No. 4 on page 8 for a description of Mina Sauk Falls.

> Northwestern Missouri contains several low waterfalls formed by resistant ledges of Pennsylvanian rock. Features 107-110 and 112-113 are well-known examples but are far from all-inclusive.

107. BETHANY FALLS

At Bethany in Harrison County, the namesake outcrop of the Bethany Falls Limestone.

108. TRYST FALLS

(Description by Richard J. Gentile*)

Clay County, 5 miles east of Kearney, in Tryst Falls Park, SE¼ NW¼ SE¼ sec. 28, T. 53 N., R. 30 W., Kearney 7½-minute Quadrangle.

Tryst Falls is about 200 feet southwest of the new Highway 92 bridge over Williams Creek. A concrete arch bridge on old Highway 92 is about 50 feet above the falls (fig. 47). The old road and bridge are still used. Excelsior Springs is about 2 miles to the east.

The waterfall is about 8 feet high and drops into a pool about 60 feet wide, 150 feet long, and 5 feet deep directly below the falls. The water drops over the eroded edge of the essentially flat-lying Bethany Falls Limestone Member which has an exposed thickness of 16 feet. The bottom was not exposed. The lower half of the Bethany Falls limestone is light gray with wavy bedding ranging from thin (knife-edge) to thick (over 2 feet). The upper 8 feet is a thin, nodular, bedded light gray limestone mottled dark gray. Major joint trend is N 45° E.

*Professor of Geology, University of Missouri-Kansas City

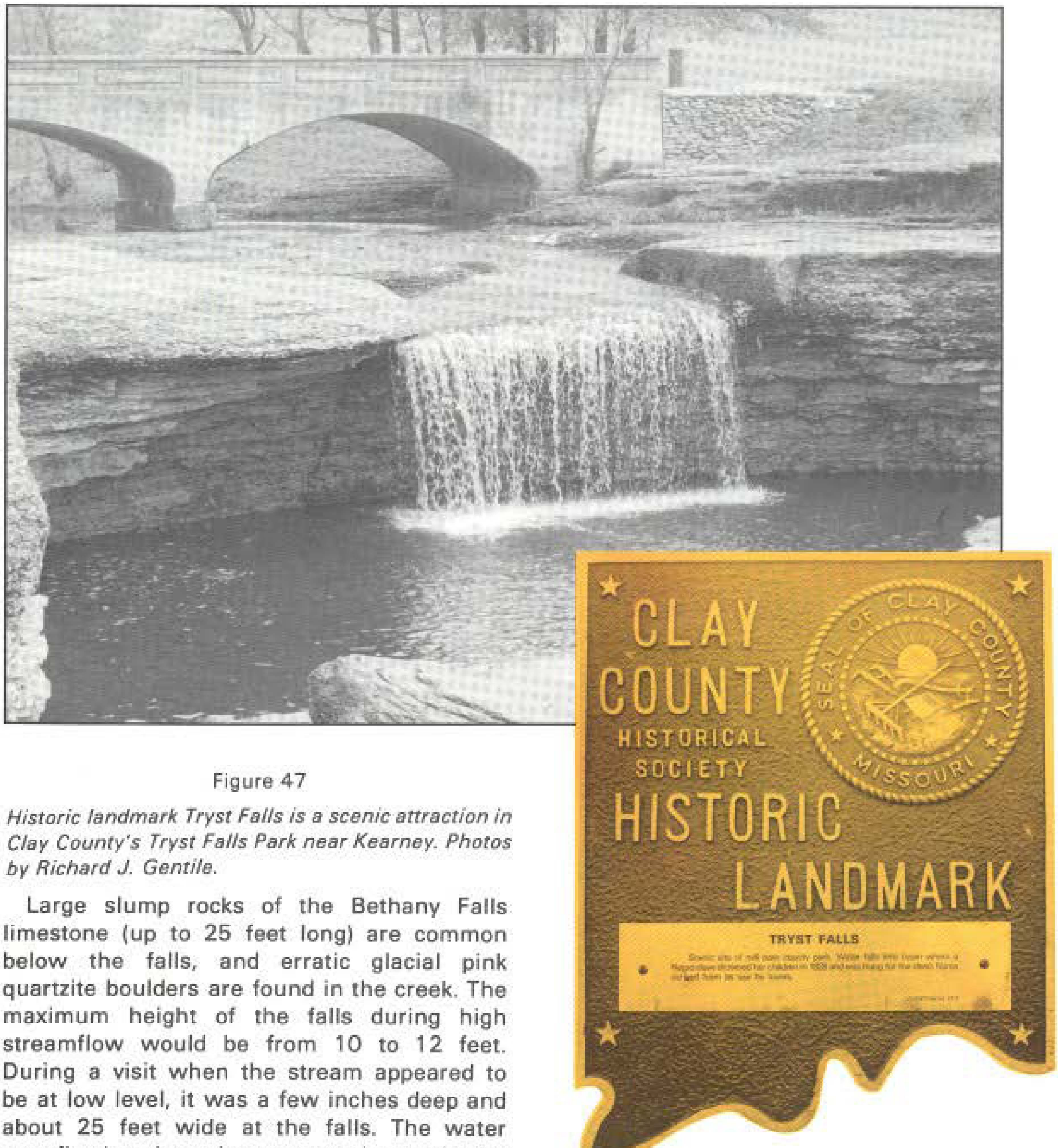


Figure 47

Historic landmark Tryst Falls is a scenic attraction in Clay County's Tryst Falls Park near Kearney. Photos by Richard J. Gentile.

Large slump rocks of the Bethany Falls limestone (up to 25 feet long) are common below the falls, and erratic glacial pink quartzite boulders are found in the creek. The maximum height of the falls during high streamflow would be from 10 to 12 feet. During a visit when the stream appeared to be at low level, it was a few inches deep and about 25 feet wide at the falls. The water was flowing through a rectangular cut in the Bethany Falls about 6 feet from the top. This depression was the result of erosion along the joints of a 2-foot slab of limestone.

The floor of an abandoned quarry on the southeast side of Tryst Falls now serves as a site for picnic tables. Tryst Falls Park is administered by Clay County. It is several acres in size and has a tennis court, baseball diamond, picnic tables, shelters, toilet facilities, and a children's playground. A Clay County Historical Landmark reads:

"Tryst Falls. Scenic site of mill now county park. Water falls into basin where a Negro slave drowned her children in 1828 and was hung for the deed. Name derived from its use by lovers."

109. BROOKLYN FALLS (JDV)

Harrison County, on the West Fork Big Creek near Brooklyn, in SE¼ sec. 28, T. 65 N., R. 28 W., Brooklyn 7½-minute Quadrangle.

The "falls" are formed by a ledge of limestone about 2 feet thick, crossing a bedrock-floored creek.

110. ROCHESTER FALLS (JDV)

Andrew County, on the Platte River, 0.25 mile west or Rochester, in NE¼ SE¼ SE¼ sec. 22, T. 59 N., R. 34 W., named on Helena 7½-minute Quadrangle.

Falls in northern Missouri are quite small by anyone's standards. Of Rochester Falls, we can say that it is a popular fishing site.

111. FALLS BRANCH FALLS AND SHELTER-ARCH (JDV)

Perry County, 2.25 miles north of Brewer, in NE¼ NE¼ sec. 21 (projected), T. 36 N., R. 10 E., Lithium 7½-minute Quadrangle.

Falls Branch Falls is a gem of a waterfall in a completely unexpected setting. The waters of Falls Branch plunge over the edge of a beautifully erosion-sculpted basin in St. Peter Sandstone. The Falls are less than 20 feet high, but the setting is so attractive and the geologic features so evident that one cannot help being favorably impressed (fig. 48).

The Falls cascade into a deep, round plunge pool that is actually the head of an unusual valley Falls Branch has carved in the massive beds of sandstone. The walls on the right, going downstream, are a continuous bluff line interrupted only by occasional little "hanging

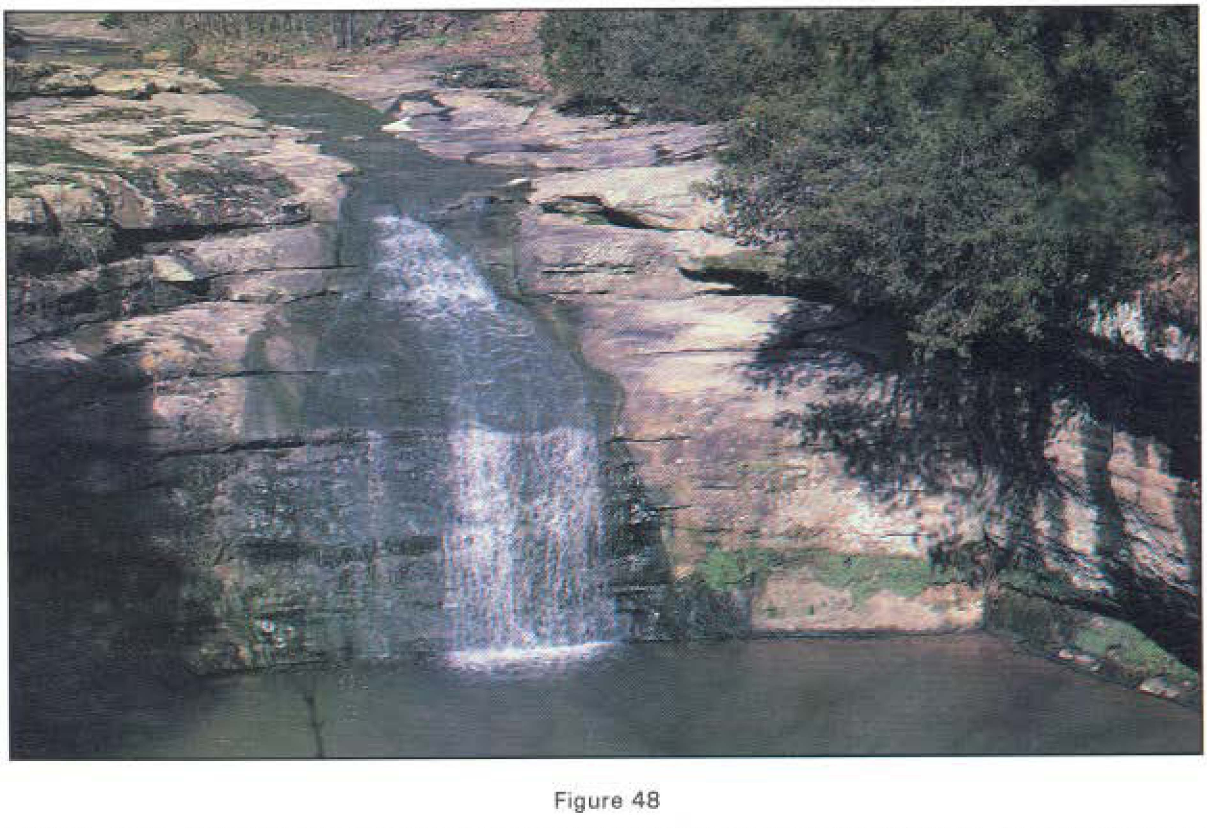


Figure 48

The St. Peter Sandstone is the geologic underpinning for pretty Falls Branch Falls, formed where the stream crosses the thick sandstone outcrop. At its best in springtime, the site boasts a natural parking lot on a sandstone bedding plane a short distance upstream from the falls. Photo by Jerry D. Vineyard.

hollows" formed as intermittent streams plunge over the sandstone valley wall.

On the left side, the sandstone outcrops are not continuous, but the occasional exposures are vertical and suggest that, were it not for alluvial deposits, the left side of the valley would also have a nearly continuous bluff line. Large trees grow along and in the valley, in a park-like setting. Farther downstream, the narrow, precipitous valley — almost a canyon — gradually expands into a broad, open area.

A few hundred yards downstream from the falls, on the left side of the valley, there is a large shelter cave about 15 feet high, with a span of some 50 feet. It is typical of shelter caves developed elsewhere in the St. Peter Sandstone, except that in this instance, the process of shelter cave development has produced an intermediate (and temporary!) feature — a natural arch.

The natural arch has the general appearance of a Western feature. It is in sandstone — the only sandstone natural arch in Missouri — and it appears so delicate that it needs protection by the overhanging shelter cave in which it grew. The gently curved arch is anchored at each end of the shelter cave, and at its thinnest part, is only a couple of feet thick.

Directions to Falls Branch Falls:

Miles

0.0 Junction of Highways 61 and M in Brewer; drive east on M to junction of Perry County Road 910; bear left on Road 910.

1.6 Drive north on Road 910.

2.0 Crossroads; continue straight ahead.

2.8 Crossroads; continue straight ahead.

3.4 Cross Falls Branch; parking area on right just after crossing Falls Branch. Park on natural sandstone exposure, and walk downstream about 100 yards to the Falls.

WONDER - VIEWERS CREED:
TAKE NOTHING BUT PICTURES;
LEAVE NOTHING BUT FOOTPRINTS;
KILL NOTHING BUT TIME...
AND ALWAYS ASK PERMISSION!

112. ROCKY FORD (SULLIVAN COUNTY) (JDV)

Sullivan County, 2 miles north of Browning, on Locust Creek, in NW¼ NW¼ NE¼ sec. 29, T. 61 N., R. 20 W., Browning 7½-minute Quadrangle.

Bedrock exposures in north Missouri are few and far between, so it's no surprise that they're popular places. Rocky Ford has been a "swimmin' hole" for as long as folks can remember. It was featured in color on the back cover of the Tourist Booklet for the Green Hills Region of North Missouri, published by the Missouri Division of Resources and Development, in the 1950's. The area is now Rocky Ford Public Fishing Access, owned by the Missouri Department of Conservation (fig. 49).

The non-fishing public will enjoy a visit to Rocky Ford, though one should not expect the clear, cool waters of an Ozark stream. A concrete slab serves as a low-water bridge over an expanse of Pennsylvanian limestone that forms a rapids in Locust Creek. The creek has cut channels and potholes in the rock to form a rugged microtopography. The visitor versed in mineralogy will find that the potholes and channels contain pebbles and cobbles of quartzite, granite, basalt, and other igneous rocks that were brought from northerly regions by glaciers during the Ice Ages. The busy traveler should also plan to see the Bairdstown Church glacial boulder (No. 367) which is some 20 miles north of Rocky Ford.

113. ROCKY FORD (LIVINGSTON COUNTY)

Livingston County, 4 miles north of Chillicothe on Thompson River, approximately center SW¼ sec. 2, T. 58 N., R. 24 W., Chillicothe 7½-minute Quadrangle.

A commercial postcard photo of this site shows rapids and a low bluff of Pennsylvanian limestone. The card describes it as *"A favorite picnicking and sunbathing spot..."* The rock ledges are (in the photo) festooned with comely lassies in bathing attire. Unfortunately, time did not permit visiting the spot; obviously summer would be the most opportune season for esthetic enjoyment.

Mrs. John Dennis, UMR graduate-student wife, provided information on this site.

Other prominent falls have been listed in conjunction with igneous rock features and shut-ins. The waterfall enthusiast should not miss Mina Sauk Falls (No. 4), Rocky Falls Shut-In (No. 45), and falls or cataracts at Johnson Shut-Ins (No. 41), Upper and Lower Stouts Creek Shut-Ins (Nos. 43 and 42), Millstream Gardens (No. 44), Silver Mines Shut-In (No. 47), and a large number of others.

Osage County has a 30-foot waterfall in conjunction with a natural tunnel (No. 306).

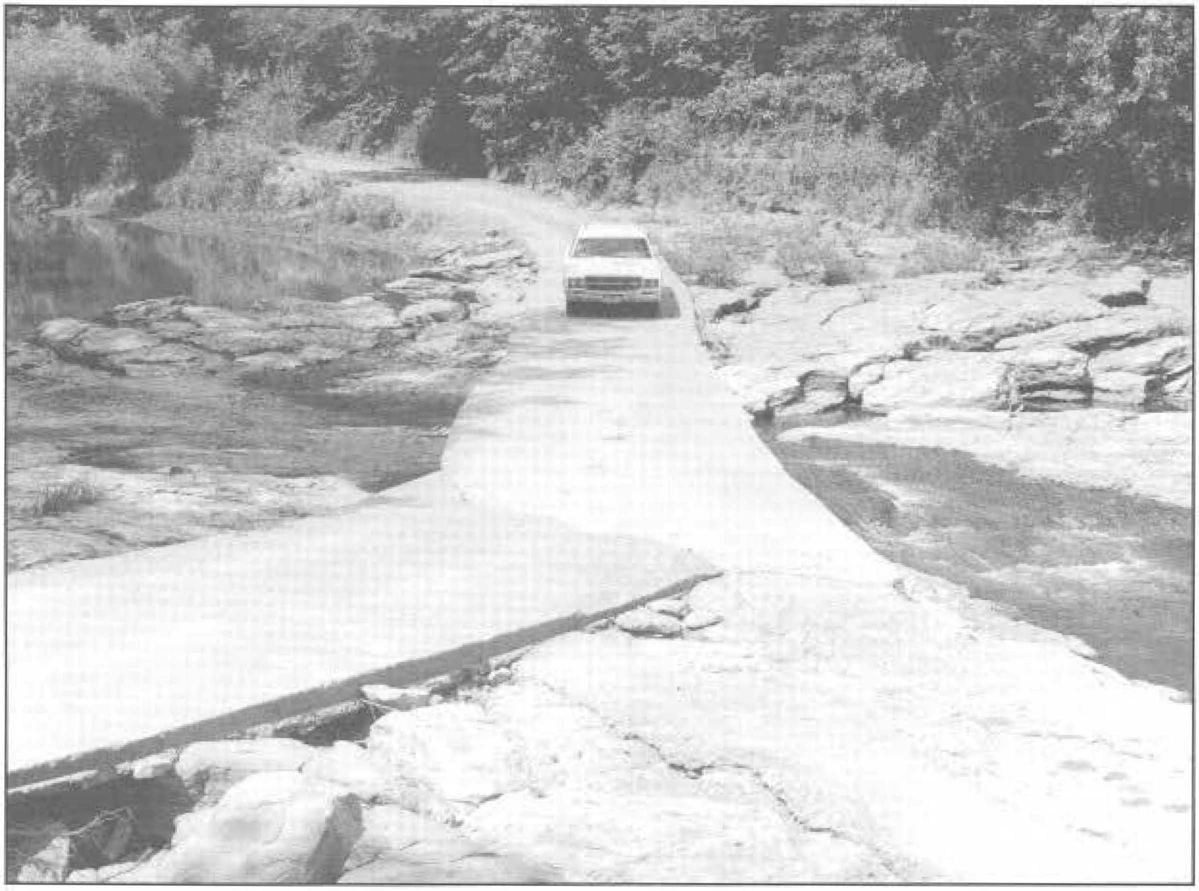


Figure 49

Rocky Ford near Browning, Sullivan County. Photo by Jerry D. Vineyard.

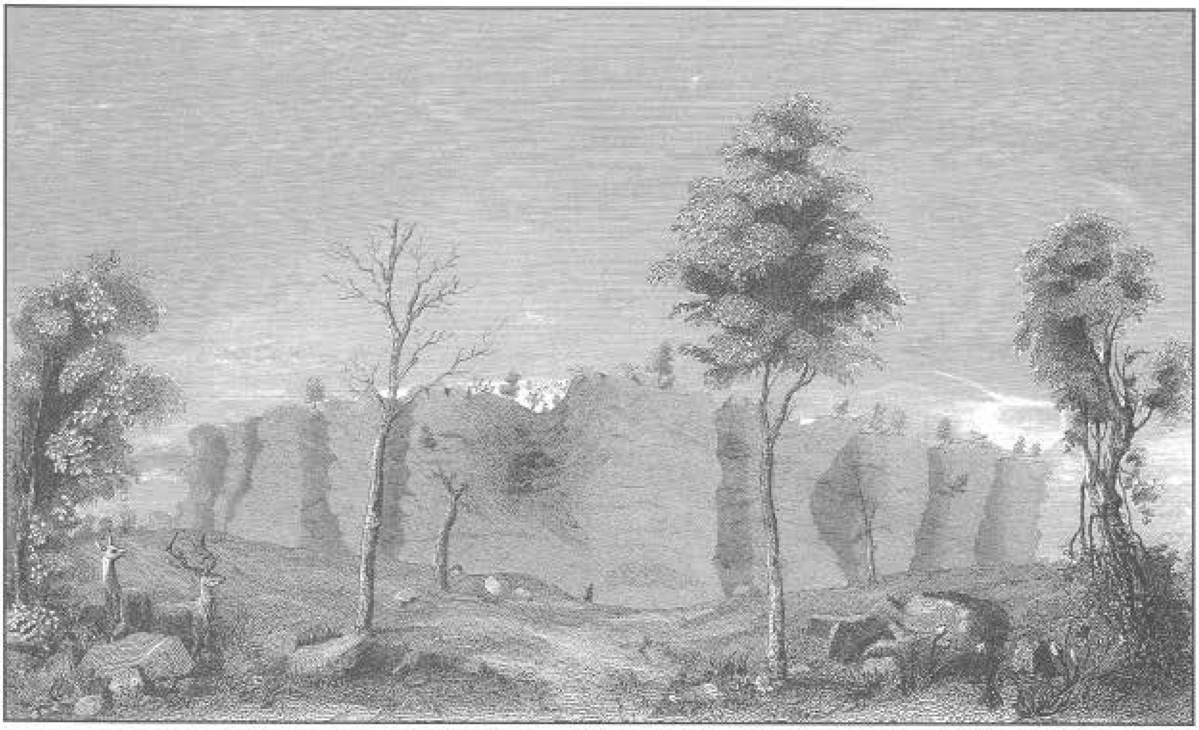


Figure 50

Highly colored bluffs of ferruginous sandstone on Turkey Creek, north of Fremont. From Swallow, 1855.

5

Bluffs

Describing, or even listing, all of the named bluffs in Missouri is impractical and even Solomon would probably have refused to pick the winner of the "Tallest and Steepest Bluff" competition. Bluffs cited herein are picked in part as likely contestants and in part because they are particularly distinctive.

One or more factors may be responsible for steep bluffs. Natural vertical fractures may be the controlling agent for some of the abnormally sheer and straight bluffs. Thickly stratified or bedded rock may contribute to vertical bluffs and the sheerness may reach its maximum on the outside of stream bends where centrifugal force makes the streams especially erosive.

Some bluffs have distinctive colorations (fig. 50). Red and brown staining can be produced by iron oxides; black stains are commonly caused by manganese oxides (lichen growths can also darken bluffs), and exceptionally white bluffs are commonly developed in limestones and dolomites.

114. CARDAREVA BLUFF

Shannon County, 5 miles southwest of Powder Mill Ferry, on the east side of Current River, in W½ sec. 36, T. 29 N., R. 2 W., Powder Mill Ferry and Exchange 7½-minute Quadrangles (fig. 51).

Within less than a quarter of a mile eastward from the Current River valley, this bluff rises approximately 550 feet above the Current River on the west flank of Cardareva Mountain. Cardareva is one of the top-seeded in the "Steepness/Height" competition.

115. BEE BLUFF

Shannon County, 8 miles northeast of Eminence, on southeast side of Current River, in the north square mile (long section) of sec. 5, T. 29 N., R. 3 W., Eminence 7½-minute Quadrangle.

The floodplain of the Current River at the base of this bluff is approximately 615 feet above sea level whereas a knob cresting this bluff has an elevation of slightly over 1,160 feet; thus the contrast in elevation is close to 550 feet within less than a half mile. Coot Mountain, 2 miles downstream from the junction of the Current and Jacks Fork, has an elevation of 1,256 feet at the Lookout Tower, rising 650 feet above the Current, but the bluffs are not as steep as at Bee Bluff.

116. TURNERS MILL BLUFF

Oregon County, on east side of Eleven Point at its junction with Hurricane Creek, upstream from Turners Mill, in E½ sec. 3, T. 24 N., R. 3 W., Greer 7½-minute Quadrangle.

This bluff, which is slightly over 460 feet high, begins a few yards upstream from

Turners Mill and deserves special recognition as an added feature enhancing this famous mill site (only the iron overshot water wheel remains). The site is 5 miles southeast of Greer Spring, Missouri's second largest spring.

117. BAINBRIDGE BLUFFS

Cape Girardeau County, 4 miles southeast of Neelys Landing, in west bluff of Mississippi River, in sec. 24, T. 32 N., R. 14 E., Ware 7½-minute Quadrangle.

Karel and Elder (1975, p. 60-61) describe this area as containing *"Spectacular limestone bluffs with several sheer waterfalls, overhangs, and ledges."* These bluffs average 200 feet high and are accessible only by foot or river.

118. GRANITE QUARRY BLUFF

Carter County, 3 miles downstream from Van Buren, on east side of Current River, sec. 32, T. 27 N., R. 1 E., Big Spring 7½-minute Quadrangle.

This bluff, a mile northeast of Big Spring, represents a 515-foot contrast in elevation from the river to the crest of the knoll, a quarter mile from the channel.

119. THE PINNACLES — LITTLE ST. FRANCIS RIVER

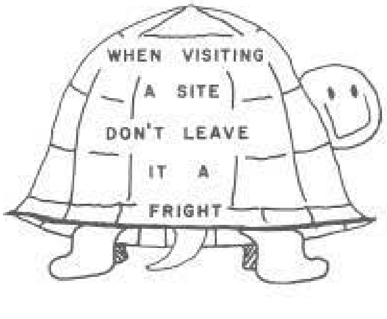
Madison County, on northeast side of Little St. Francis River, 8 miles west of Fredericktown, SW¼ NW¼ SW¼ sec. 19, T. 33 N., R. 6 E., Rhodes Mountain 7½-minute Quadrangle (fig. 51).

The Pinnacles are not easy to reach but a visit to the site is worth a considerable amount of time and effort. Differential weathering of vertically fractured pink porphyry created a sheer bluff cresting a hundred feet above the bed of the Little St. Francis River. Individual columns rising as monoliths above the bluff are responsible for the name, but the bluff per se is even more spectacular than the pinnacles. The site could well be compared to the Palisades of the Hudson and merits photography but defies the lazy or poor planner.

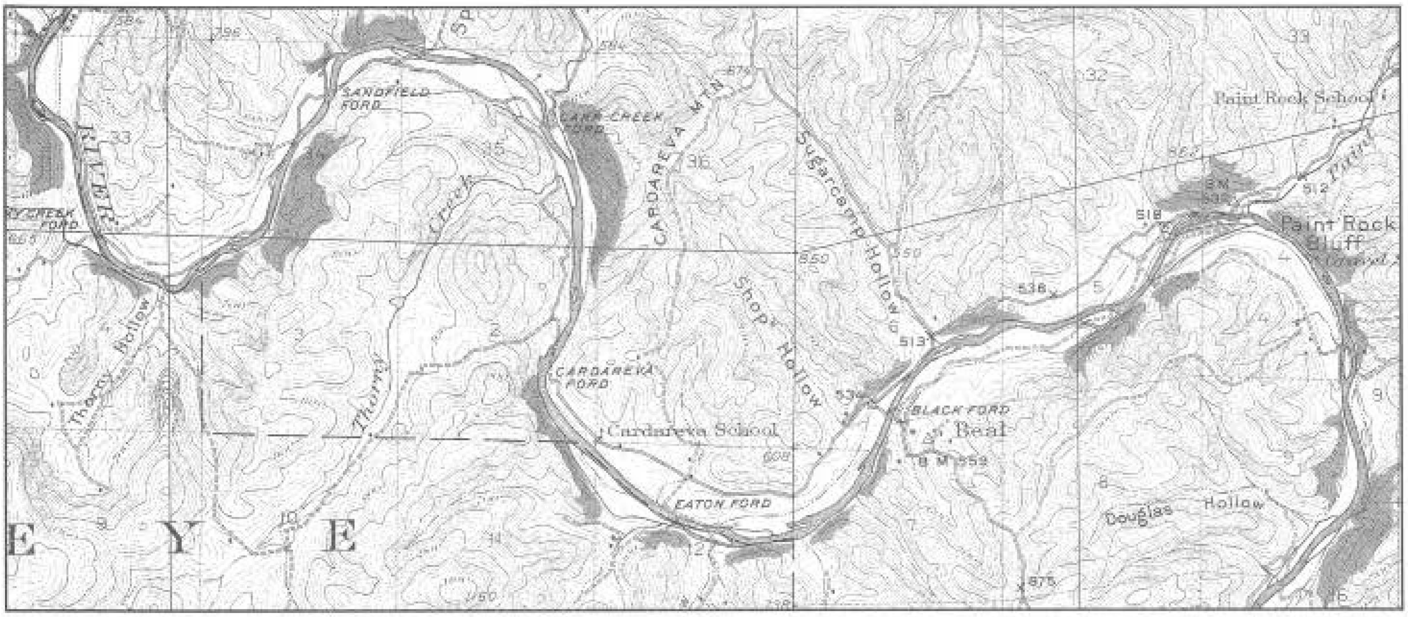
They can be reached by taking Highway 72 west from Fredericktown to Highway D (road to Silver Mines Recreation Area) and turning left (south) off D onto a gravel road 1.3 miles from Highway 72. This road follows Pine Mountain southwestward to private property. The owner was most hospitable and cooperative but understandably prefers not to have a horde of visitors. He kindly gave permission to drive a challenging trail which is shown on the 1947 Fredericktown 15-minute Quadrangle. This trail turns sharply to the northeast a few yards from the township line and goes down to the river valley.

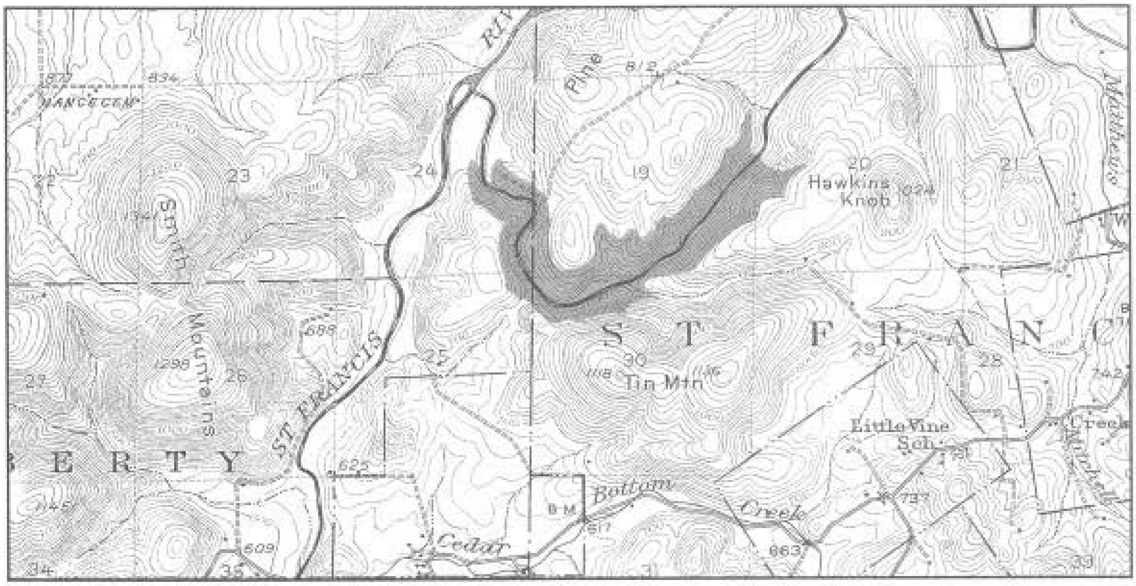
The Pinnacles are south of the trail immediately east of the township line. Unfortunately, they are not easy to photograph from the east bluff and photos would require a telescopic lens, shooting upstream from a point where the bluff bends sufficiently to get an angle shot.

The best photography would be from the opposite side of the river. This fact, coupled with respect for the owner's privacy, suggests floating the stream which is a challenge because of shut-ins and exceptionally fast water, or entering overland from the south side of the river. The south approach would utilize Highway T southwest from Fredericktown combined with a bit of the pioneer spirit. The bluffs are awe-inspiring and a visit via the southern route for color slides would be worthwhile.



Topography from USGS Cardareva 15-minute Quadrangle


RIVER
SANDFIELD FORD
CANN CREEK FORD
CARDAREVA MTN
Sugarcamp Hollow
Shop Hollow
Thorny Hollow
Thorny Creek
CARDAREVA FORD
Cardareva School
EATON FORD
BLACK FORD
Beal
B M 559
Paint Rock School
Paint Rock Bluff
Douglas Hollow
E Y E


RIVER
Pine
Hawkins Knob
Smith Mountains
ST FRANCIS
Tin Mtn
S T F R A N C
Little Vine Sch
Bottom Creek
Cedar
E R T Y
Matthews
Creek

Topography from USGS Fredericktown 15-minute Quadrangle

Figure 51

CARDAREVA BLUFF (top): The Current River has hundreds of scenic bluffs; one of the most picturesque reaches of the river is between the mouth of Rocky Creek and Paint Rock Bluff. Cardareva Bluff, highest in this reach, rises over 550 feet above river level.

THE PINNACLES (bottom): The Little St. Francis River plunges from a meandering course over sedimentary rocks through volcanic (rhyolite and felsite) rocks of the Precambrian Middlebrook Group to reach its mother stream, the St. Francis. The river's violent passage has left a long, bluff-lined shut-in distinguished by the Pinnacles. The southwesterly course of the St. Francis River here is controlled by geologic faulting in the igneous rocks.

120. BLUFFTON-RHINELAND BLUFFS

Montgomery County, along Highway 9, along north wall of Missouri River valley, from town of Bluffton, 6 miles west of Rhineland, east to Rhineland, in secs. 32-36, T. 46 N., R. 6 W., Gasconade 7½-minute Quadrangle (fig. 52).

These bluffs rank among the most impressive followed by any Missouri highway and have the virtue of being visible from the highway the year around. Vegetation distribution is ideal — not enough to hide the sheer dolomite faces and cedar-dotted overhangs, yet sufficient to produce excellent fall coloration. For highway scenery (looking upward!) this 6-mile stretch is one of Missouri's prides.

The bluffs are 400 feet high, essentially vertical, and are composed of Jefferson City Dolomite. Hikers and bicyclists using the Missouri River Trail have the best access to the bluffs.

Even higher bluffs (450 feet of relief) flank the Missouri on the south side 2 miles below the mouth of the Gasconade, but the break at the foot of the bluffs has been preempted by the Missouri Pacific Railroad.

121. TURKEY MOUNTAIN

Barry County, 5 miles southwest of Shell Knob, on the west shore of Table Rock Lake, in SW¼ sec. 30, T. 22 N., R. 25 W., Golden 7½-minute Quadrangle.

The crest of this mountain is a bit over 1,400 feet above sea level; thus it is approximately 500 feet above water level with the greater part of its east flank forming an awesome bluff.

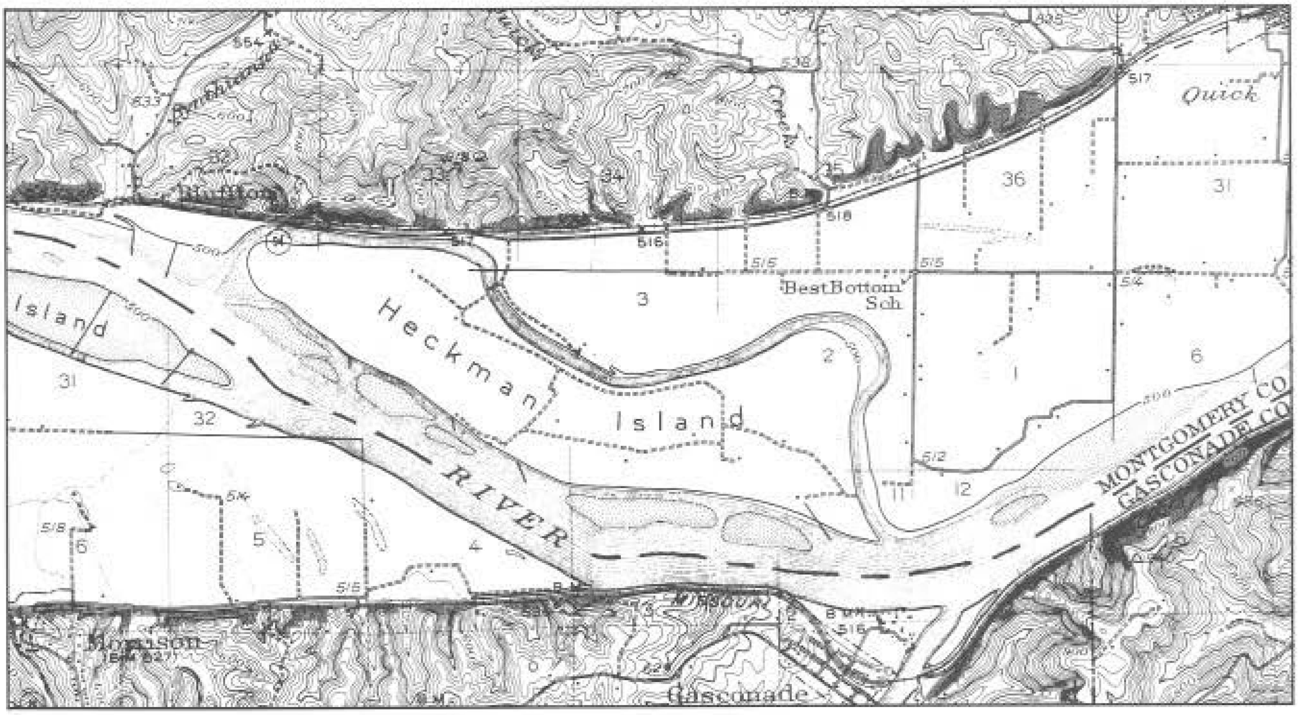


Figure 52

There are many bluffs along the Missouri River, typified by the Bluffton-Rhineland reach. The valley cuts a wide swath through dolomite bedrock, leaving spectacular bluffs as the river meanders, cutting along one bank and then the other, leaving occasional islands in its wake. The place names (Gasconade, Rhineland) reflect the central European heritage of the people, as well as the Ozark tradition for simple, descriptive names (as Bluffton) and local history (Heckman Island, named for a steamboat captain). Topography from U.S. Geological Survey Morrison 15-minute Quadrangle.

122. CLIFF DRIVE

Jackson County, in North Terrace Park, Kansas City, along south bluff of Missouri River, between Highway 269 and junction of I-29 and I-35, secs. 33-36, T. 50 N., R. 33 W., Kansas City 7½-minute Quadrangle.

Parizek and Gentile (1956, p. 29) describe this famous landmark as follows:

"It is now a park area but was a favored site in the late 19th and early 20th centuries for the location of stately mansions of wealthier Kansas Citians. The Kansas City Museum now occupies one of these structures. The Argentine limestone underlies Cliff Drive and is continuously exposed along the southwest wall of the Missouri River."

The Museum is on the highest knob along the bluff, being 250 feet above the Missouri River floodplain. All of the limestones and shales in the bluff are Pennsylvanian in age.

123. ELK RIVER OVERHANGING BLUFFS

McDonald County, between Lanagan and Noel, along Missouri Highways 59 and 90, secs, 11, 14, and 15, T. 21 N., R. 33 W., Noel 7½-minute Quadrangle.

McDonald County gained ephemeral fame in 1961 by establishing itself as McDonald Territory after the county name was left off the Missouri Official Highway Map of that year. County officials may have forgotten their proper anger and the publicity value may be gone, but the exceptionally scenic overhanging bluffs endure (fig. 53).

These bluffs are best developed along Highway 59 between 4 and 4.5 miles south of Lanagan and along Highway 90 from Noel northwest to the junction with Highway 59. The overhanging bluffs, which completely shelter the road along some stretches are formed by lower Mississippian limestones. These limestones are underlain by the relatively nonresistant, easily eroded Noel or Chattanooga shale. As a result, in the not-too-distant geologic past, Elk River undercut the bluff and created a phenomenon which justifiably is the subject for many travel brochure photos.

Familiarity does not dull the fascination of these bluffs which, coupled with the clear waters of Elk River, make trips to Noel a pleasure. Commercial caves and tasteful lodges in the area further enhance its attraction. Undoubtedly the white man's predecessors considered this a choice area with caves and overhanging bluffs providing shelter and the clear springs and streams providing drink and game.

124. THE PALISADES — ST. LOUIS

St. Louis, South Broadway from Mount Pleasant Street to northern tip of Bellerive Park, Cahokia 7½-minute Quadrangle.

Flannery (1961) has given us a thorough description and assembled historical data on this 60-foot jagged limestone bluff and the homes crowning it. The St. Louis Landmarks and Urban Design Commission has declared the 10-block bluff line a city landmark and a spokesman for the Commission compared the area to the White Cliffs of Dover. At the foot of the bluff are the Missouri Pacific tracks; atop the bluff the patriarch of homes, the Herman Walz mansion, dominates the architecture. This Gothic house, at 4708 South Broadway, was begun in 1849 and is five stories high on the bluff side.

Because of vegetation, the bluff would be most properly photographed in the winter, during the morning looking west from the Mississippi shore.

ASK PERMISSION...
AVOID A CUSSIN'

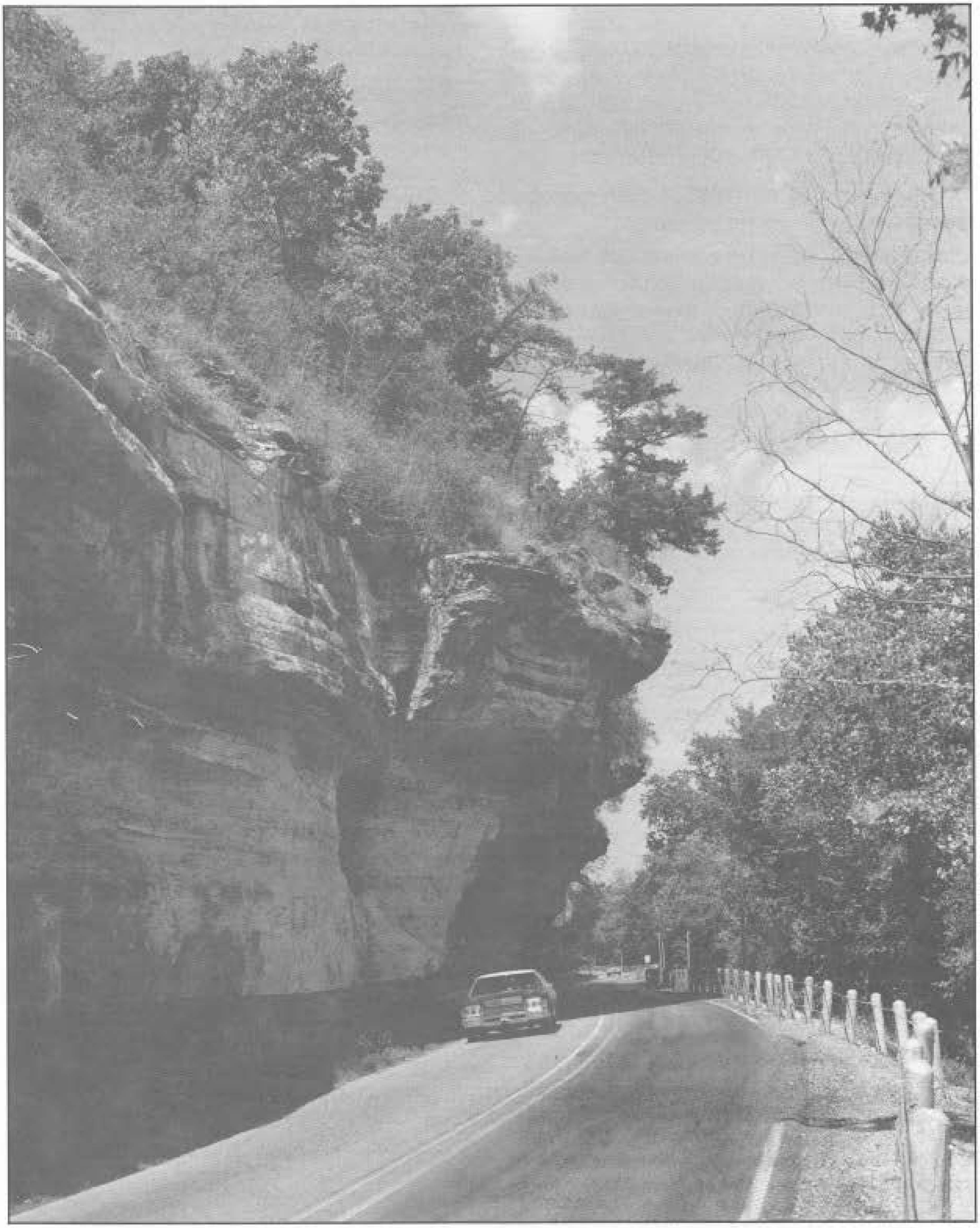


Figure 53

Elk River overhanging bluffs near Noel. Photo by Jerry D. Vineyard.

125. THE PALISADES — ST. LOUIS COUNTY

St. Louis County, in north bluff of Meramec River between Jedburgh and Glencoe, 2 miles north of Times Beach, in northern part of sec. 19 and northern and eastern part of sec. 20, T. 44 N., R. 4 E., Manchester 7½-minute Quadrangle.

Sheer bluffs of Ordovician limestones rising 200 feet above the floodplain of the Meramec form The Palisades. These bluffs are sheer in part because they are on the outside of a stream meander loop and thus have been vigorously eroded as a result of centrifugal force acting on the river current. Of the five bluff segments between Glencoe and Jedburgh, the third one east of Glencoe is the most pinnacled and the fourth one is the most impressive.

As is common along limestone and dolomite bluffs, cedars hug the bare rock and deciduous trees prevail on the gentler slopes. Fortunately, the bluff faces are sufficiently bare to be impressive in summer as well as winter.

This area is noted for its fall colors, a virtue created in part by the profusion of hard maples, and a fall drive along the Old State Road thence southeast to Jedburgh is most rewarding. The Palisades are best seen from the river or from the south floodplain. These bottoms were reached by going north from I-44 at the Williams Road interchange, east of the Meramec opposite Times Beach by the following route:

Miles	
0.0	*Williams Road interchange; go north and thence west to Old Highway 66 in front of Galley West.*
0.3	*Bear right (north) onto Lewis Road.*
1.9	*Bear right on Lewis Road into Crescent.*
2.2	*Bear left, cross railroad tracks, and bear left again.*
2.65	*Bear right.*
3.7	*Blacktop bears left; Palisades visible on opposite side of Meramec.*

TAKE TIME TO SMELL
THE FLOWERS...
BUT DON'T PICK 'EM!

126. THE PALISADES — CAMDEN COUNTY

Camden County, 5 miles north of Linn Creek, in east bluff of Lake of the Ozarks, west of Damsel and opposite Linn Creek Bend, in E½ sec. 20 and S½ SE¼ sec. 17, T. 39 N., R. 16 W., Camdenton 7½-minute Quadrangle.

Although these bluffs have lost some of their impressiveness as a result of impoundment, they have not lost their identity and are named on the topographic map. They rise approximately 230 feet above the water and thus are still sufficiently healthy and impressive to have patrician social status in the area.

127. SELMA PINNACLES

Jefferson County, in bluffs of Mississippi, 4 miles below Crystal City, between Selma Station and Rush Tower, in secs. 25 and 36, T. 40 N., R. 7 E., and sec. 31, T. 40 N., R. 6 E., Selma 7½-minute Quadrangle.

Swallow (1855, p. 146-147) in describing outcrops in the Mississippi bluffs from St. Louis downstream to Commerce says:

"Leaving Selma, we find a continuous line of bluffs extending to Rush Tower, the dis-

tance being about four miles. This portion of the river is remarkable for its picturesque scenery, which reminds one forcibly of the Mississippi above Prairie du Chien [Wisconsin]. The Silurian [Ordovician] strata are constantly exposed in bold, perpendicular cliffs, towards the tops of the hills, while, below, are wooded slopes, covered with huge blocks of limestone, reaching to the margin of the water. In some instances the strata have been weathered in such a manner as to leave standing, isolated, tower-like masses, from twenty to thirty feet high, as represented in the cut."

Swallow, the first State Geologist of Missouri, referred to the cut on page 147 of his Second Annual Report for 1853-1855. It is reproduced here as figure 54. These bluffs rise over 300 feet above Harlow Island and might make good subjects for morning photography from the island.

128. PICTOGRAPH BLUFF (GREAT STONE FACE)

Jefferson County, on northeast bluff of Big River, 1.5 miles northeast of Fletcher near common east corners of secs. 20 and 29, T. 40 N., R. 3 E., Fletcher 7½-minute Quadrangle.

A report prepared by Harland Bartholomew et al. (1968, p. 158) describes these pictographs as probably the best preserved in Missouri and states that they are believed to be approximately 1,060 years old. It further says:

"...the most prominent motif depicted in the pictographs along Big River is a concentric circle, sun symbol, about 30 inches in diameter. To the left of this symbol, and about 25 inches above it, is a slightly smaller circle which has a much heavier outline and a solid round center.

"...in addition to these sun symbols on the same bluff is a bird-like assemblage. Its claw-like left wing touches a circle, and its arrow-like other wing points to the opposite direction. Though these paintings are practically inaccessible, when viewed from across Big River, the topmost portion of cliff has a remarkable face-like appearance. In 1940, Winslow M. Walker of the Smithsonian Institute studied them and suggested that some ingenious medicine man may have painted the symbols, and together with a natural face-like feature of the bluff, used them to his advantage."

On this same page a photograph shows the face-like appearance of The Great Stone Face which is a front view rather than a profile with the eyes formed by deep re-entrants in the rock.

The site was visited near dusk in January but the pictographs were still visible under such unfavorable conditions. Identification of the Stone Face was not certain but despite the poor visibility resulting from the time of day and hazy atmosphere, the pictographs were obvious, offering ample reward for the visitation.

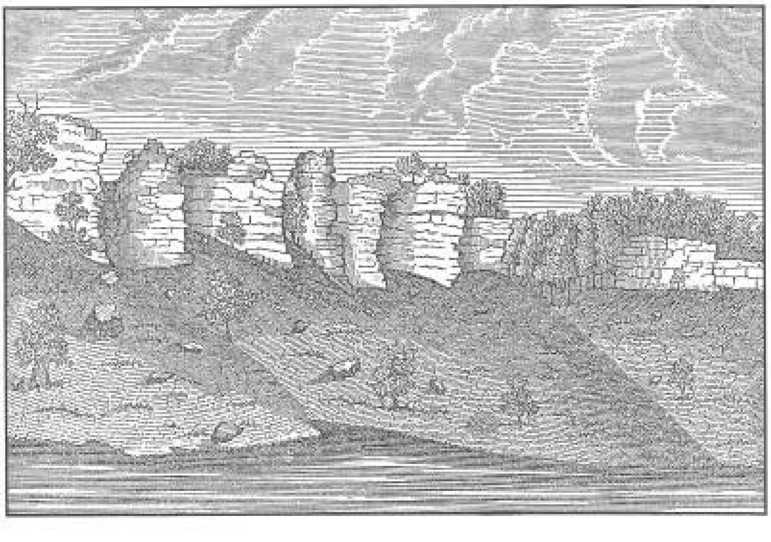


Figure 54

Bluffs on the Mississippi River between Selma and Rush Tower. From Swallow, 1855.

The following route was used to reach the area:

Miles

0.0 *Junction of Highways H and WW, west of Fletcher (west of DeSoto) in extreme western Jefferson County; go north on Highway WW.*

2.5 *Road off WW to the right (east) with sign identifying Stewart Brothers Angus Farm. Follow this road eastward and down long hill to barn on right-hand side at 3.1 miles where road bears left and continues along flank of north-facing slope, past club houses to farmhouse at 3.9 miles. The conspicuous bare dolomite bluff containing the pictographs is visible when looking to the east-northeast from the farmhouse; one could probably identify the pictographs from this point with binoculars. From the farmhouse, a trail leads east-northeast down the slope across Calico Creek (which required wading in depths of over a foot) and thence to the right through a field opposite the pictograph bluff. The bluff is best observed from this field and the bottomlands between it and the river. The view was sufficiently impressive to produce a strong temptation to return at a more opportune time with binoculars and a telescopic lens!*

129. WAYNESVILLE ROCKFALL

Pulaski County, on south side of Gasconade River, 4 miles northwest of Waynesville, near center SE¼ SE¼ SE¼ sec. 17, T. 36 N., R. 12 W., Ozark Springs 7½-minute Quadrangle.

One of the most spectacular rockfalls in Missouri occurred on, or about, November 3, 1971 (fig. 55). It involved the breaking away of a section of vertical cliff approximately 200 feet long, 60 feet high, and 20 feet thick, and the collapse of thick-bedded dolomite into the Gasconade River.

The reason for the collapse is evident. Prior to the rockfall, the vertical cliff contained a vertical fissure parallel to its face and some 20 feet back of it. Weathering had contributed to making the rock unstable and the entire mass finally separated along the fissure. The separation might well have been aided by freeze-thaw activity of water trapped in the fissure as well as pre-existing fractures within the portion which fell.

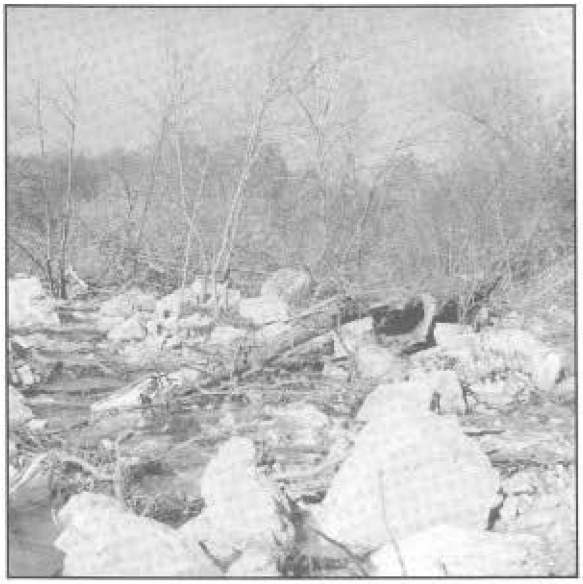


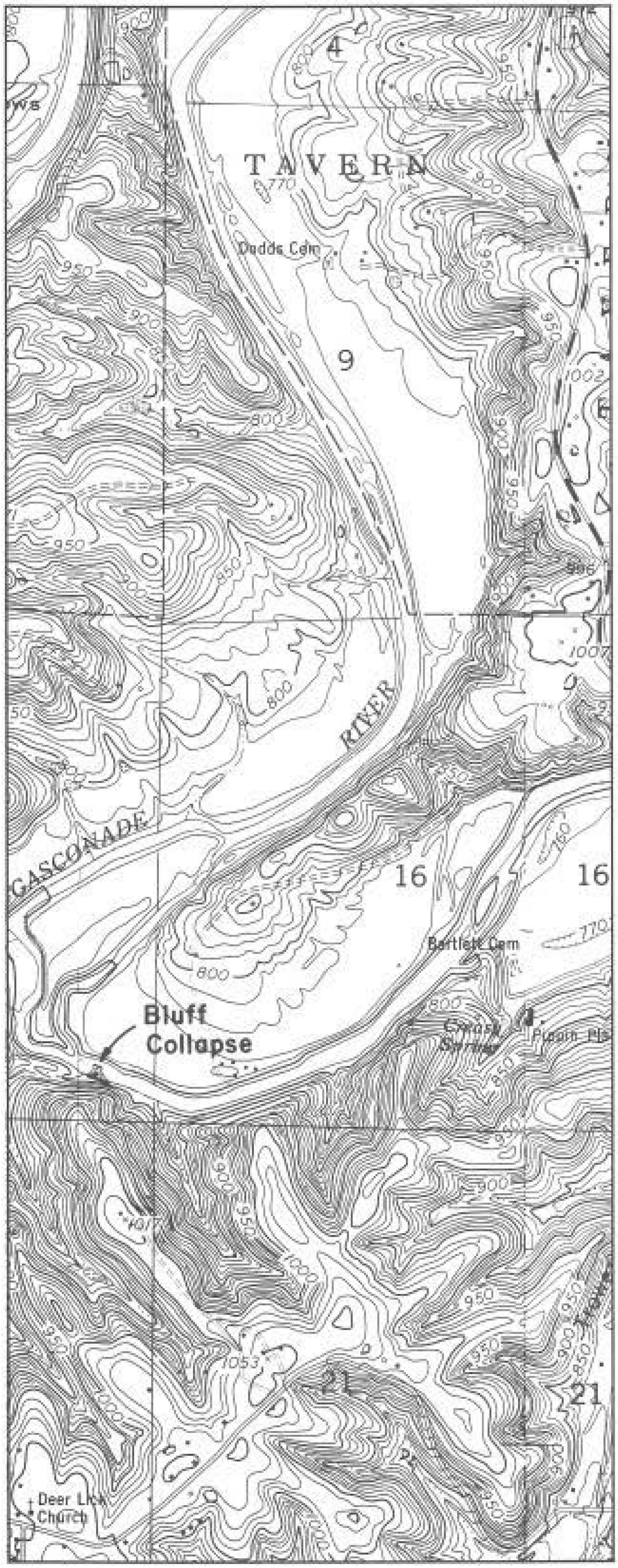
Figure 55

Waynesville rockfall. Photo by Jerry D. Vineyard.

The material is Gasconade Dolomite which tends to be thick-bedded and to contain vertical fractures producing vertical cliff faces. Because of the thick-bedded nature of the rock, individual blocks are commonly quite large when it does fracture. Characteristically, this formation is a host for major springs and caves in the general area and solution activity along the vertical crevice produced the fissure which was a factor in the rockfall.

The site was visited very shortly after the fall and two other observers with technical backgrounds estimated the dimensions of the portion which fell. Averaging those two estimates and a personal one resulted in the figures cited above for dimensions; the computed weight of the fallen material was approximately 20,000 tons.

The huge blocks which collapsed into the Gasconade River produced a setting reminis-



cent of some shut-ins and raised the water level about 4 feet, producing excitement for float fishermen and a haven for fish. Eventually the Gasconade may shift its channel somewhat to the left around the rockfall, which completely covered the channel. Some rocks even bounded onto the opposite bank.

The area is especially impressive from the air where one can see the exceptionally even, vertical plane of the new face and note that the grain of this new face is reflected in a similar grain about 0.5-mile to the west, suggesting that the fracture system is not as localized as the rockfall might suggest.

Those who float major streams in the Ozarks where vertical bluffs are common probably marvel that such rockfalls are not more frequent. Obviously they have occurred in the past but recorded events of this large scale are unusual.

The slide was reached by driving north on Highway 17 from Waynesville and turning off this highway slightly over 2 miles after crossing the Gasconade River. This left turn was onto a gravel road which eventually forked and became quite rough. At the fork, the left-hand branch was taken and followed to a gate which was subsequently locked because of the great amount of visitation resulting from a lot of publicity. From the locked gate a lane shown as a double dotted line on the topographic map leads past an old farmhouse and southwestward to a point where the slide is easily seen. In addition to the Ozark Springs 7½-minute Quadrangle, a Waynesville 7½-minute Quadrangle facilitates navigation (fig. 56). The bluff faces almost due north and the complete site is probably best photographed on an overcast day with plenty of exposure time (fig. 57).

Figure 56

Parts of the Ozark Springs and Waynesville 7½-minute Quadrangle maps show the bluff collapse on the Gasconade River. Geologists will note that the collapse occurred on the concave side — the "cutting edge" — of a meander loop.

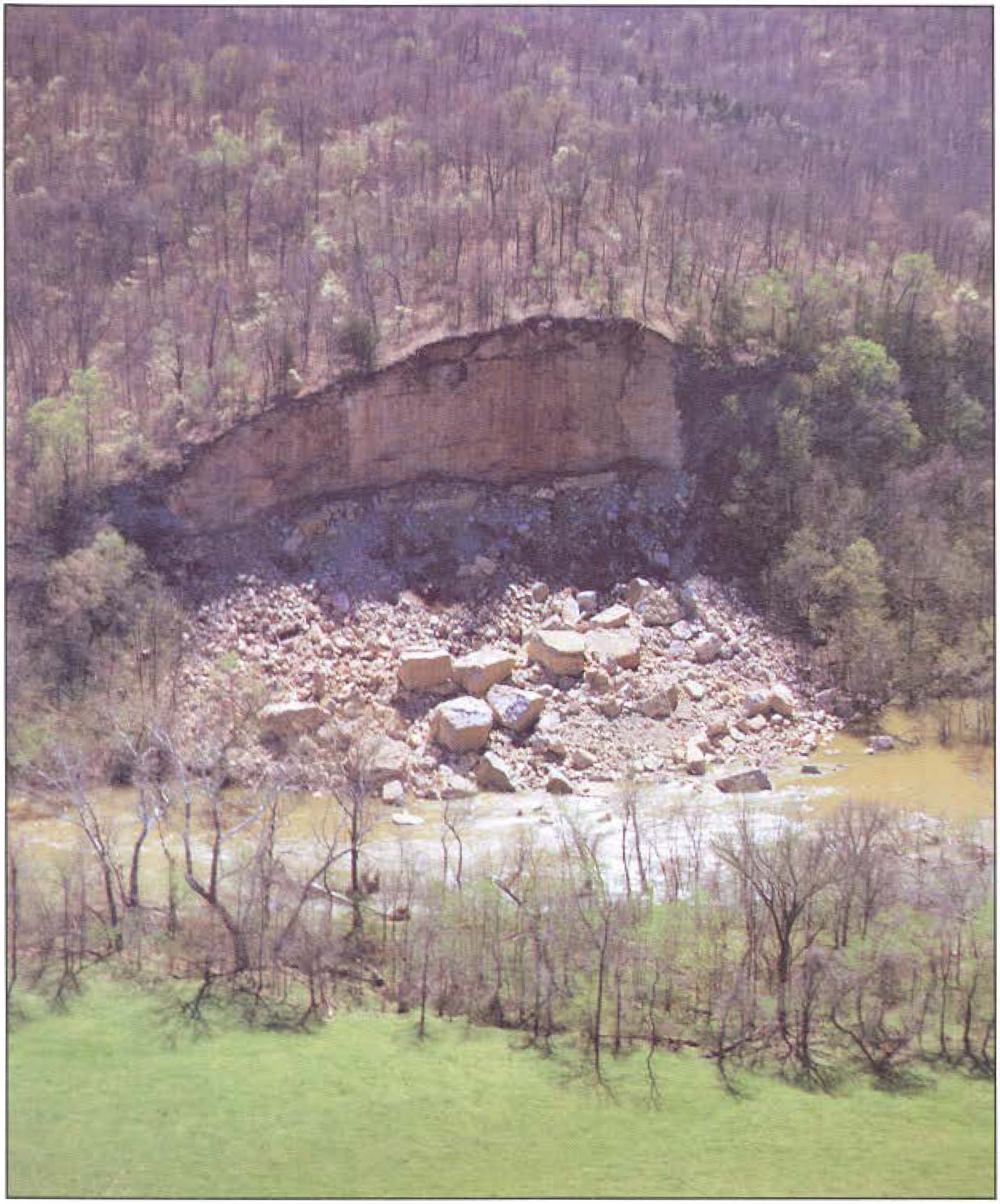


Figure 57

This aerial view of the November 1971 bluff collapse on the Gasconade River near Waynesville was taken in early April 1972 (note dogwood in bloom). The solution-weakened joint plane along which the collapse occurred is apparent. Photo by Jerry D. Vineyard and James H. Williams.

130. CHIMNEY ROCK BLUFF (ROCK PILE MOUNTAIN)

Madison County, on east side of St. Francis River, 2 miles southeast of French Mills, in NW¼ SE¼ NW¼ sec. 25, T. 32 N., R. 5 E., Rock Pile Mountain 7½-minute Quadrangle.

Chimney Rock Bluff was visited with the prime intention of finding and describing Chimney Rock. The variety of features on the bluff is so great and captivating that a major sin of omission resulted — namely a failure to get dimensions of Chimney Rock!

The Bluff is Bonneterre(?) dolomite and is one of the best examples seen in Missouri of a variety of features produced from weathering in a fractured environment. Two major fracture systems are prominent. One trends N 50° W parallel to the bluff line and the other is at right angles to it. Differential weathering along the system at right angles to the bluff line has produced rock peninsulas or abutments jutting from the bluff; weathering along the system parallel to the bluff has breached these peninsulas to leave pinnacles and chimneys directly overlooking the valley (fig. 58).

The bluff was explored starting at the south end where copious notes were taken on dimensions and orientations of the variety of features. As work proceeded to the north, the variety of features became so overwhelming that the most isolated pinnacle, Chimney Rock, became lost in the crowd and was all but ignored as it became obvious that at least a half day could be spent in describing the general locale (fig. 59).

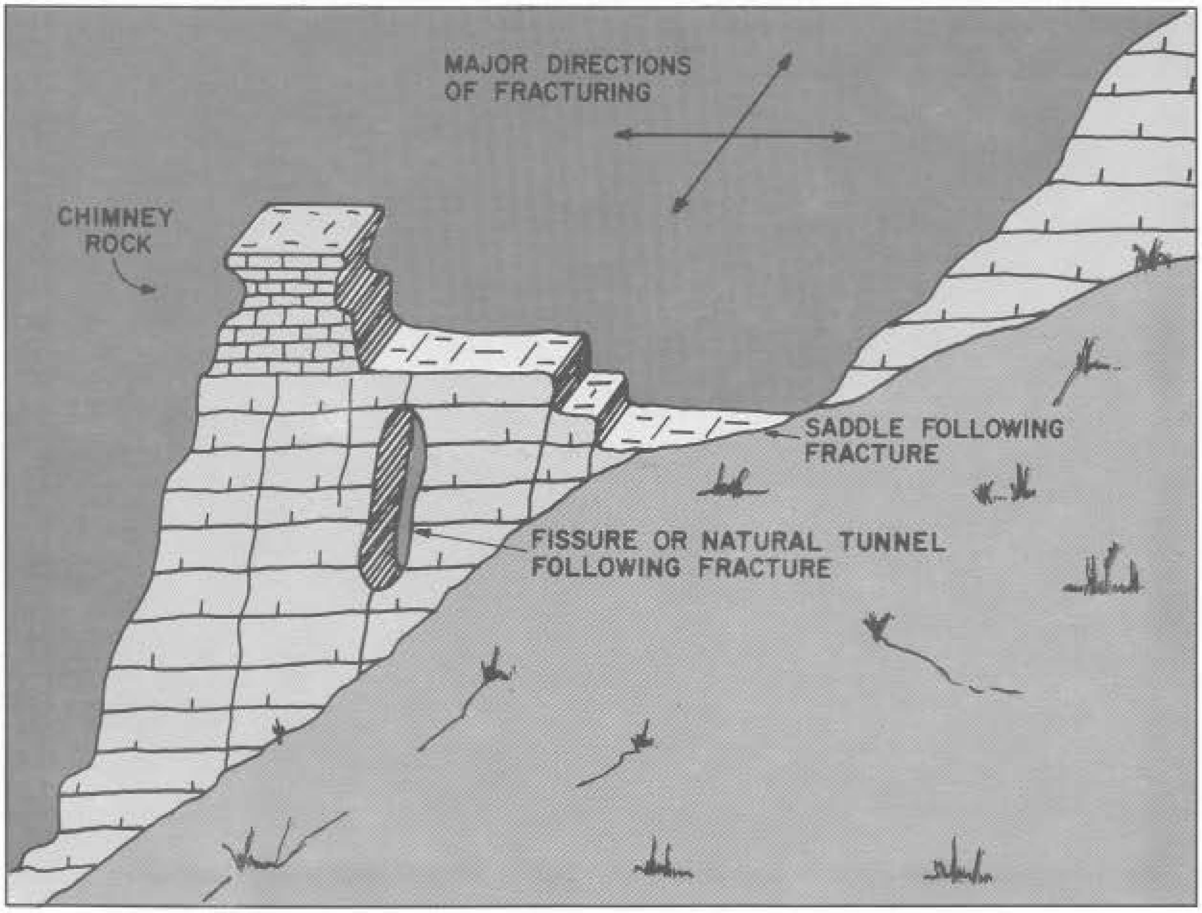

MAJOR DIRECTIONS OF FRACTURING
CHIMNEY ROCK
SADDLE FOLLOWING FRACTURE
FISSURE OR NATURAL TUNNEL FOLLOWING FRACTURE

Figure 58

Diagrammatic sketch of abutment-pinnacle development at Chimney Rock Bluff.

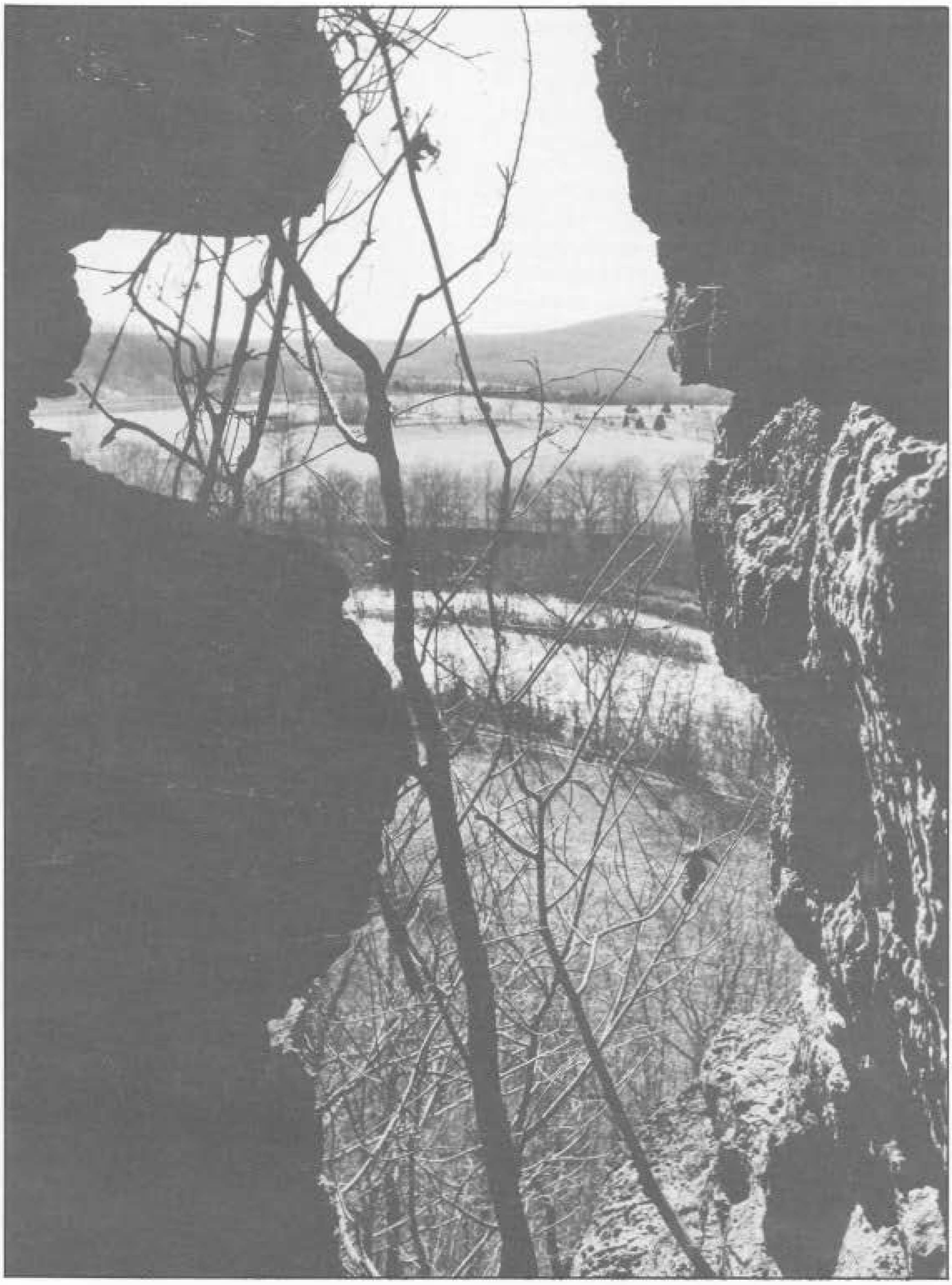


Figure 59

Pinnacles and bluffs in the Rock Pile Mountain Wilderness Area overlook the St. Francis River. Photo by Roger Pryor.

At the second abutment from the south end of the pinnacle system, a fracture parallel to the bluff line has been enlarged by solution to produce a natural tunnel 5 feet in maximum height, 2 to 3 feet wide at the base, and 15 to 20 feet long. The top of the fissure continues upward as a major fracture system which can be traced parallel to the bluff to the next pinnacle to the southwest where it forms a saddle separating the southernmost observed pinnacle from the main mass of the bluff. This fissure or natural tunnel contains a narrow fissure at right angles to it which penetrates the pinnacles and emerges on the pinnacle face overlooking the valley. Up slope from the fissure a second, a parallel fracture, has been enlarged to produce a fissure 5 feet wide and 6 feet tall capped by a slab of dolomite which has partly collapsed and dips or slopes toward the main bluff line to produce a natural tunnel which has only a few years (geologically speaking) to live.

The bluff line contains at least a half-dozen of these abutment-like protuberances with isolated knobs of varying heights. Chimney Rock, shown in figure 60, is slightly north of the center of the system. The locale is a gem for photography, for easy climbing and crawling, and for a geology exercise in studying the relationship between weathering along fractures with the variety of topographic forms produced. Photography would be best when foliage is at a minimum.

A map showing hiking trails and interesting features of Rock Pile Mountain was obtained at the Fredericktown Ranger District office of Mark Twain National Forest at Fredericktown. According to this map, Rock Pile Mountain is so named because of a roughly circular pile of stones at the crest of the mountain in the southeast corner of sec. 30, T. 32 N., R. 6 E. The map states that this circle was about 4 feet high in early 1900's but has been reduced to its present level by human activities. It is believed to be of human origin, perhaps Indian, and was noted when the area was first settled by white men.

The map also shows a very scenic shut-in in the west half of the same sec. 30 (No. 88).

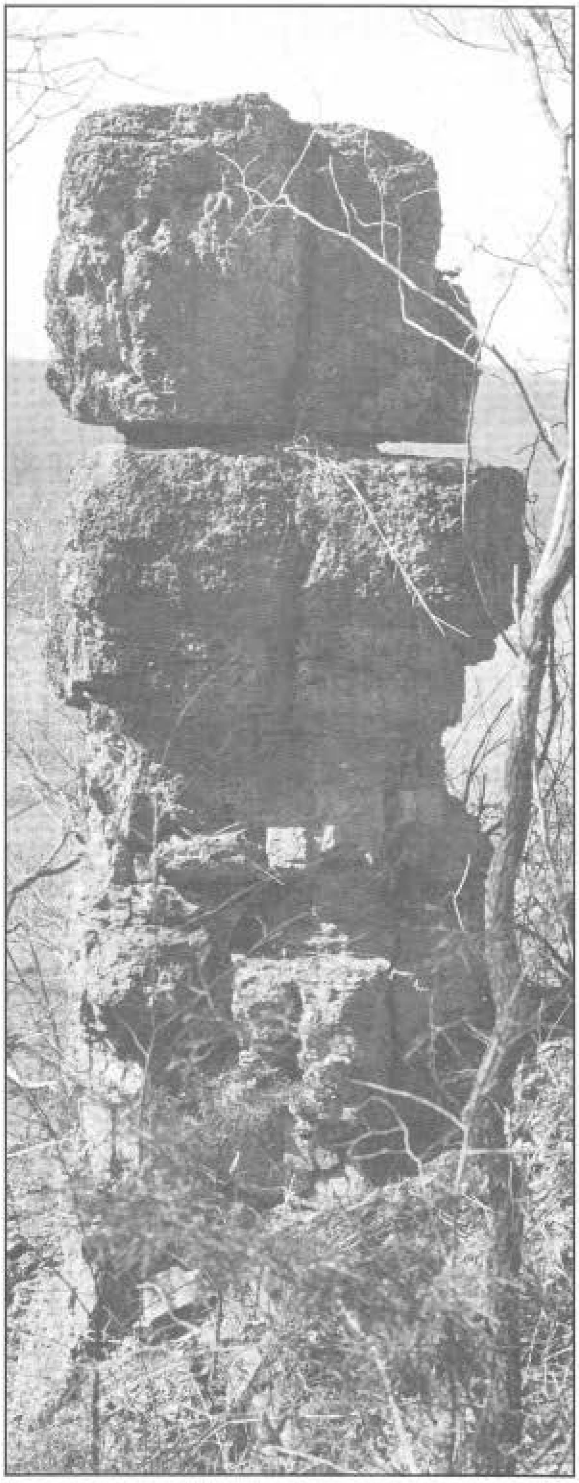


Figure 60

Chimney Rock on Rock Pile Mountain. Photo by Roger Pryor.

This was not visited but could be reached by foot from Chimney Rock Bluff.

The bluff was reached by the following route:

Miles

0.0 *Junction Highways E and O, 6 miles southwest of Fredericktown. Go south on Highway O.*

4.9 *End of Highway O; continue south on gravel road.*

5.0 *Bear right at fork.*

5.5 *Low water bridge; bear left.*

6.0 *House on right.*

6.45 *Bear left, cross concrete bridge, then bear left to house. Park and follow trail to east and south to next house south. Climb slope southeast of house and work south along bluff where pinnacles are quite obvious.*

131. SUTTON BLUFF

Reynolds County, on West Fork Black River, 4 miles northwest of Centerville, near common north corners of secs. 13 and 14, T. 32 N., R. 1 W., Corridon 7½-minute Quadrangle.

This U.S. Forest Service Recreation Site includes camping facilities, deep and shallow stream water, and a 400-foot bluff. The site was not visited, but the *Geological Map of Missouri* and photographs indicate that Sutton Bluff is composed of Cambrian rocks, probably the Eminence Dolomite.

A BULL MAY NOT OWN
HIS PASTURE, BUT
IF HE THINKS HE
DOES, HE DOES !

The Mark Twain National Forest map shows a road about 4 miles long going northwest from Missouri Highway 21, less than 2 miles north of Centerville. This road goes to the Recreation Site and also connects with Forest Service Road 2236 which in turn connects with the Karkagne Scenic Drive road. The Mark Twain National Forest Map is an excellent, almost indispensable navigational aid.

132. CASTLE ROCK BLUFF

Bollinger County, on west side of Castor River, 1.2 miles south of Missouri Highway 34, in center E½ sec. 31, T. 30 N., R. 8 E., Gipsy 7½-minute Quadrangle.

Castle Rock Bluff is composed of Gasconade dolomite which has been weathered to a pinnacled surface in its upper part. It should be visited during the winter when foliage is at a minimum. The hardy who are immune to poison ivy can easily climb the moderate slope from the gravel road at the base. The site was visited in August and time did not permit a reconnaissance along the entire bluff, but enough pinnacling was observed to verify that it has earned its name. Reportedly the castellated profile extends with some breaks for nearly half a mile from the north end, which was climbed.

The site was reached by turning south off Missouri Highway 34 at the west end of a secondary bridge west of the main bridge across Castor River. The gravel road was followed for 1.2 miles to the beginning of the pinnacled bluff line on the right side of the road.

133. SUGAR LOAF ROCK

Cole County, in south bluff of Missouri River, 3 miles north of Elston, in W½ NW¼ sec. 13, T. 45 N., R. 13 W., Hartsburg 7½-minute Quadrangle.

This site was not visited. Its name undoubtedly was inspired by its appearance as viewed from the Missouri River or its valley.

PIKES PEAK

Missouri has not one, but *two* Pikes Peaks. Compared to their famous namesake in Colorado, the Ozark cousins are insignificant. Nevertheless, people in two widely separated parts of the state were impressed enough with their hills to name them after the intrepid Zebulon Pike.

Pikes Peak Bluff in Camden County appears to be about 200 feet higher (920+ feet) than Pikes Peak in Ste. Genevieve County, whose highest contour is 720 feet.

134. PIKES PEAK BLUFF

Camden County, on west side of Niangua River, in NW¼ sec. 35, T. 37 N., R. 18 W., Macks Creek 7½-minute Quadrangle, on which it is named.

135. PIKES PEAK

Ste. Genevieve County, in sec. 23 (projected), T. 38 N., R. 7 E., Weingarten 7½-minute Quadrangle, on which it is named.

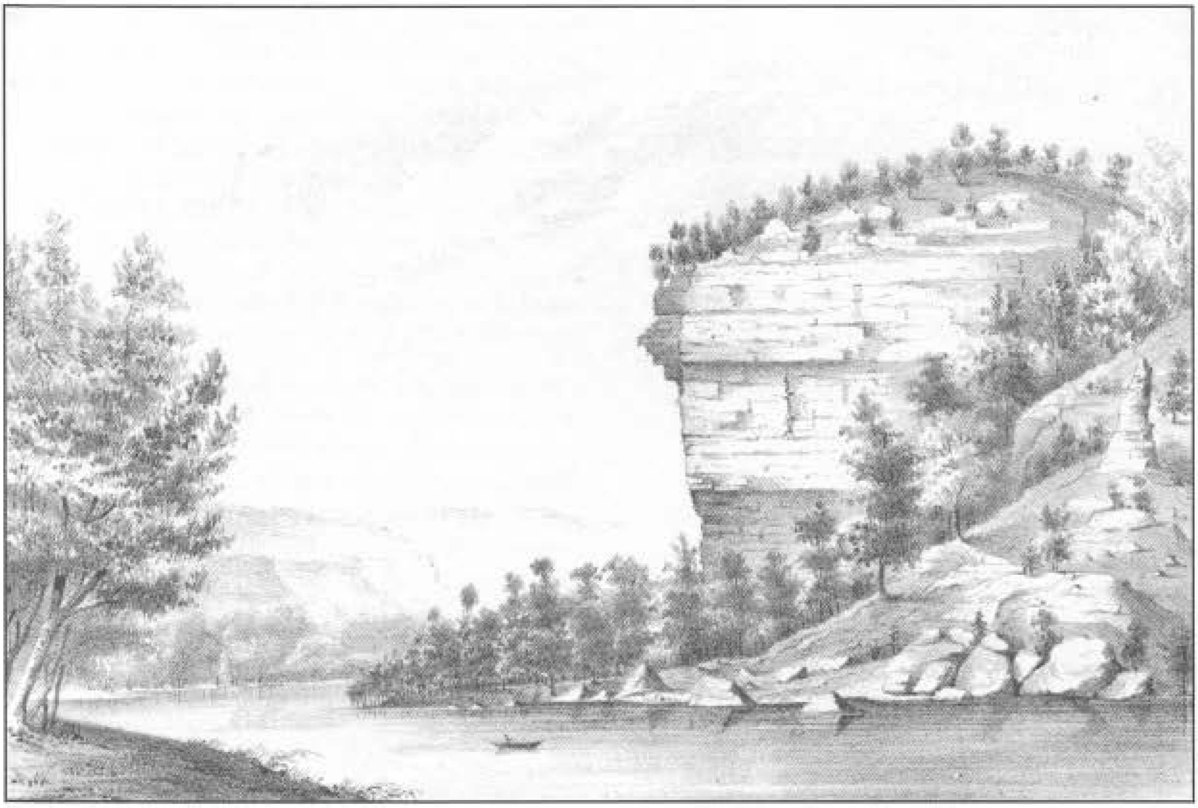


Figure 61

Missouri has several bluffs for "leaping lovers" such as this one on the Osage River near the mouth of Tavern Creek. From Broadhead, 1873.

LOVERS LEAPS

There are several places in Missouri, where, legend has it, unhappy lovers have sought eternal bliss by leaping into space (fig. 61). This listing of Lovers Leaps is undoubtedly incomplete, for some are not identified as such on topographic maps and appear to have no diagnostic topographic characteristics.

136. LOVERS LEAP (FULTON)

Callaway County, in Fulton, on 5th Street, SW¼ NW¼ NW¼ NW¼ sec. 16, T. 47 N., R. 9 W., Fulton 7½-minute Quadrangle.

Leaping lovers in Fulton have some chance of survival because this urban bluff is only a 60-foot one. It is composed of chert conglomerate (cemented gravel) and a sandstone cemented with iron oxide. The material is the Graydon Formation of Pennsylvanian age. A major disadvantage of this Lovers Leap would be the low flow of Stinson Creek, the danger of falling short of the stream, and the possible urban pollution which would tend to take some of the romance out of a histrionic leap. The impressive bluff with an overhanging crest faces south and would be a good subject for winter photos.

The Leap may be reached by going east on East 5th Street for 0.15 mile from its junction with Highway 54 at the traffic lights. A lane leads south (to the right) at this point between Grand Avenue and Bluff Street immediately east of 306 East 5th.

137. LOVERS LEAP (CAMDENTON)

Camden County, 5 miles north of Camdenton, at north end of Lake Road 5-89, in NE¼ sec. 35, T. 39 N., R. 17 W., Green Bay Terrace 7½-minute Quadrangle.

The creation of the Lake of the Ozarks has reduced the efficacy of Lovers Leap north of Camdenton, but 120 feet of relief still remains above the lake surface to supply a tolerable quota of free fall and a fine splash for those who can muster sufficient spring to clear that bluff and land in the water.

138. LOVERS LEAP (RIPLEY COUNTY)

Ripley County, on south side of the Current River, across from Deer Leap Recreation Area, in S½ SE¼ sec. 6, T. 23 N., R. 2 E., Briar 7½-minute Quadrangle, on which it is named.

This lovers leap is not appropriate for those who can't swim, because the Current River makes a direct frontal assault on the base of the bluff, and is thereby deflected 90° eastward. However, the view (last, in the case of despondent lovers) is exceptional because it affords a view of Deer Leap across the river, and another peculiar feature called Pigs Ankle, a slough off the Current River about 0.75 mile north of Lovers Leap.

139. LOVERS LEAP (HAHATONKA)

Camden County, at Hahatonka (see No. 339 for exact location).

Despite the Lake of the Ozarks impoundment which reduced the height of Lovers Leap at Hahatonka, the leaper (or leapress) has nearly 250 feet of freeboard above the lake level and a much sheerer bluff than that of Lovers Leap north of Camdenton. The only available lore indicates that the Osage Indian Princess Niangua was the heroine of this legend.

140. LOVERS LEAP (WATERLOO)

Clark County, 3 miles northeast of Kahoka, on Fox River, in sec. 9, T. 65 N., R. 7 W., Kahoka 7½-minute Quadrangle.

Waterloo, Missouri was once the county seat of Clark County, having been laid out in 1837. By 1874 (according to Campbell, p. 147) its population was 75. On the modern topographic map, its only identity is through Waterloo Bridge and Waterloo Cemetery.

Goodspeed (1887, p. 343-344) relates that Old Floyd, a half breed, vied with a young Indian chief for the affections of a "dusky maiden." The two men fought on a bluff near Waterloo, Floyd wounding his antagonist and pushing him over a cliff into Fox River. The maiden then married Floyd who whipped her one day when he was drunk and,

> *"...Then she, with the memory of her murdered lover still in her heart, threw herself from the same cliff, and left Floyd a widower."*

The site thus became known as Lovers Leap.

This version was encountered after returning from field work in northern Missouri and the location is speculative. According to the topographic map, the steepest local bluff on Fox River is that immediately south of the Waterloo Bridge. This 70-foot bluff, which best fits the specifications for a Lovers Leap, is on the east line NE¼ SW¼ sec. 9, T. 65 N., R. 7 W., 3 miles northeast of Kahoka. Undoubtedly the serious student of Lovers Leaps could pinpoint the location of the bluff with a bit of local historical research.

141. LOVERS LEAP (CLINTON)

Henry County, at west edge of Clinton, near west end of Water Street, on east bluff of Town Creek, in N½ SE¼ NW¼ SW¼ sec. 3, T. 41 N., R. 26 W., Clinton South 7½-minute Quadrangle.

Lovers Leap at Clinton resembles Lovers Leap at Fulton in being developed on a bluff of Pennsylvanian strata. At Clinton, Pennsylvanian shales capped by a resistant sandstone result in a bluff which rises about 50 feet above Town Creek and faces toward the setting sun. Unfortunately, no leads could be obtained on lore regarding the fallen person or persons.

142. LOVERS LEAP (SILOAM SPRINGS)

Howell County, 3 miles northeast of Siloam Springs, 2 miles north of Highway 14 and 1 mile east of Highway AP, in northeast corner sec. 21, T. 25 N., R. 10 W., Siloam Springs 7½-minute Quadrangle.

This site was not visited. The location was provided by Mr. Terry Collins, geology student at the University of Missouri-Rolla. The topographic map shows a 70-foot bluff on the north side of Kenyon Hollow. Regardless of the impressiveness of this bluff, the local area is unusually scenic. Several miles to the west, the oft-photographed Missouri Highway 14 arch bridges over North Fork were awe-inspiring to a Corn Belt native. The views from Siloam Springs and the fire tower to the north have been cited as among the most rewarding in the Missouri Ozarks. Perhaps the Biblical miracle of sight-restoration at Siloam is emulated to a lesser degree at this namesake town?

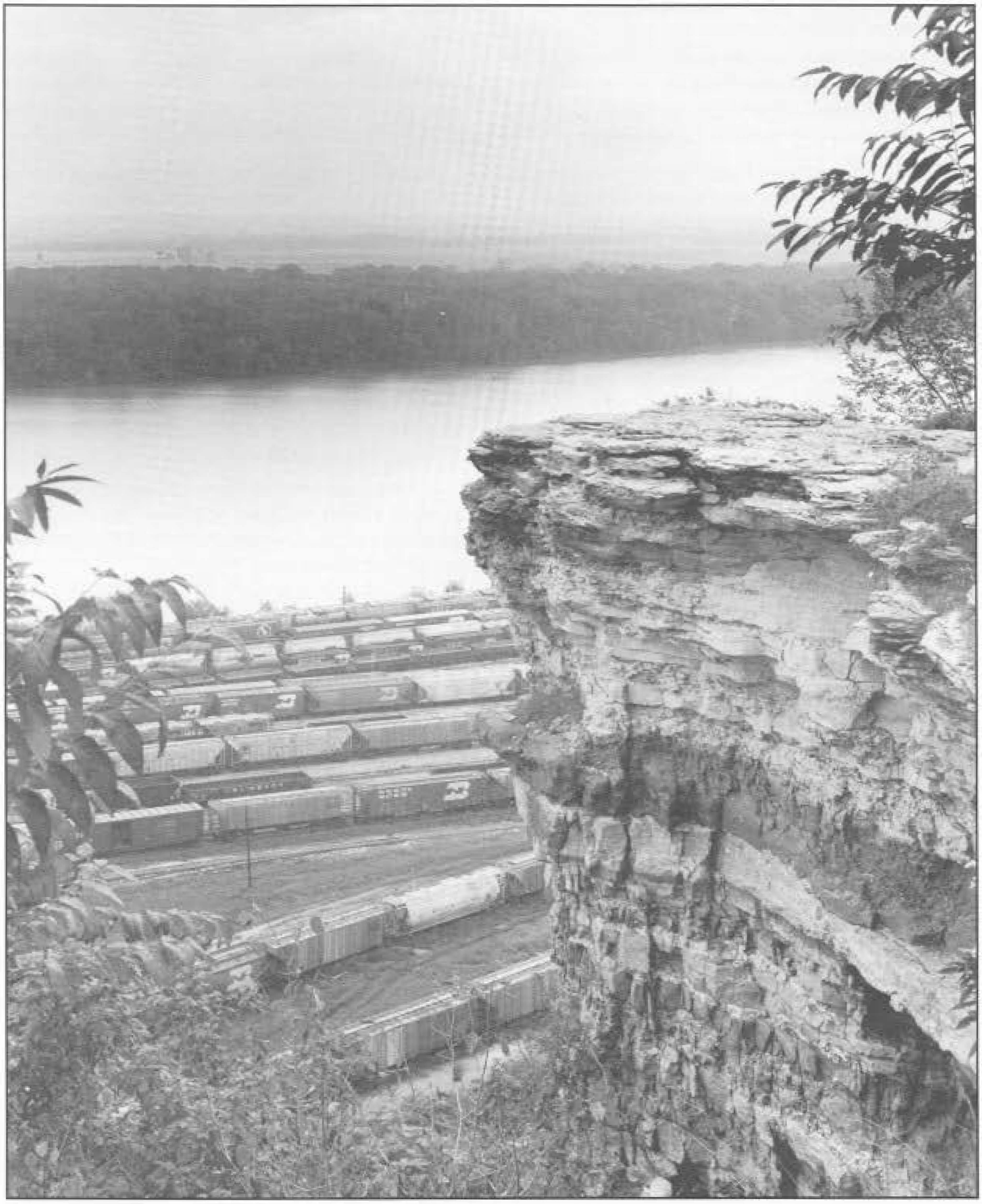


Figure 62

Lovers surviving leaps from Lovers Leap in Hannibal could count on trains finishing the job ... Rock is the Burlington Limestone. Photo by Jerry D. Vineyard.

143. LOVERS LEAP (HANNIBAL)

Marion County, on Mississippi River bluff, at southeast edge of Hannibal, in common south corners of secs. 27 and 28, T. 57 N., R. 4 W., Hannibal East 7½-minute Quadrangle.

This famous Lovers Leap (fig. 62) is composed of limestones, shales, and siltstones capped by the Burlington Limestone which, in turn, has a meringue of loess. The 250-foot bluff has the standard lore associated with it and, in addition, some authentic history. With the belief that the world was coming to an end in 1843, William Miller from New York City spread his doctrine sufficiently to have a strong following from Hannibal and the nearby area. These "Millerites" were disappointed in 1843 but held another vigil on October 22, 1844. They dressed in long white robes and waited on the crest of Lovers Leap to be carried to heaven at the time of the Second Coming which, according to available information, has still not yet transpired.

A visit to Hannibal is not complete without a drive to the top of Lovers Leap to enjoy a panorama of the town and the broad valley of the Mississippi. At the crest is Burlington Limestone containing the button-like fossil remains of an invertebrate sea animal, the crinoid. It is capped by brown loess which contains swallow nests hollowed out of the vertical face. The truly adventurous may walk out on the Burlington Limestone promontory — especially designed to solve unrequited love problems. Concern has been expressed regarding the stability of this promontory; thus, the prospective leaper should exercise due caution.

From Hannibal, go southeast on Highway 79 for 0.75 mile from Broadway and turn left off 79 to ascend a hill on a steep, winding blacktop road. Those coming in from the southeast on Highway 79 should turn right an even mile from the turnoff to Mark Twain Cave. Because the quarter-mile drive to the crest is steep and the road is narrow, consider brakes and weather beforehand.

144. INDIAN LEAP BLUFF

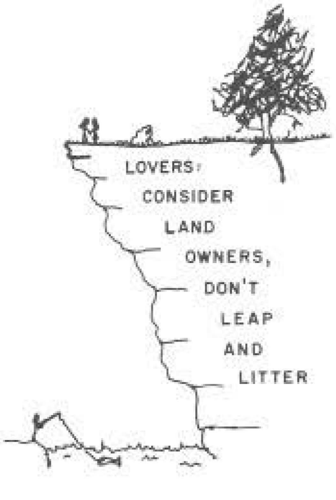
Laclede County, 4.5 miles west of Eldridge, on the east side of Niangua River, in SE¼ NE¼ sec. 30, T. 36 N., R. 17 W., Eldridge West 7½-minute Quadrangle, on which it is named.

Another variation on the lovers leap theme, this bluff comes with no specific legends; there is also a nearby Jumpoff Hollow that is part of the drainage toward the Niangua River.

145. DEER LEAP

Ripley County, at Deer Leap Recreation Area, Ozark National Scenic Riverways, in S½ SE¼ sec. 6, T. 23 N., R. 2 E., named on Briar 7½-minute Quadrangle.

A variation on the Lovers Leap theme, Deer Leap is a bluff on Current River. See also Hahatonka area, Camden County; the high bluff there is named Deers Leap Hill.



ROCK SHELTERS

146. SHELTER VALLEY OVERHANGING BLUFFS

Jefferson County, 4 miles west of Pevely and Herculaneum, west half of sec. 22, T. 41 N., R. 5 E., Herculaneum 7½-minute Quadrangle.

Shelter Valley provided a year-round haven for prehistoric man. In the summer he might have preferred the northwest-facing shelter; in winter, the southeast-facing solarium. The area is represented on the topographic map by contour lines forming a scalloped pattern on both sides of a northeast-draining valley which heads near the center of the SW¼ sec. 22, T. 41 N., R. 5 E. Additional shelters reported in the northwest-draining tributary, which heads near the southwest corner of the same section, were not checked. Vineyard (1971, p. 91-96) described these shelters and their genesis in detail and included a map showing their distribution.

The overhanging bluffs are in the St. Peter Sandstone and have variable dimensions with some reaching a height of 25 feet at the outer extremity and an equivalent re-entrant depth into the bluff to form a cove at the junction with the floor (fig. 63). Probably weathering by freeze-thaw action has been the main agent for deepening the re-entrants. As ground water near the exposed sandstone froze, it expanded and caused disintegration of the rock. The activity may be confined to the particular horizon of the shelters because of greater permeability which permitted percolating ground water to be especially plentiful for the freeze-thaw action.

Visitors should remember their archaeological manners should they be tempted to check the material swept under the rug by prehistoric housekeepers. Digs should not be conducted without permission of the property owners, and should be carried out and recorded under the supervision of technically knowledgeable persons.

The area was reached via the following route:

Miles

0.0 Junction Highway Z and I-55 west of Pevely; head west on Z.

2.1 Powerline crosses road.

3.3 Turn right off Z onto secondary road.

3.8 Park and walk east across field about one-eighth mile to Shelter Valley.

(Those going east on Highway Z from Hillsboro should turn left off the highway 1.8 miles northeast of the Z and A junction at Mapaville).

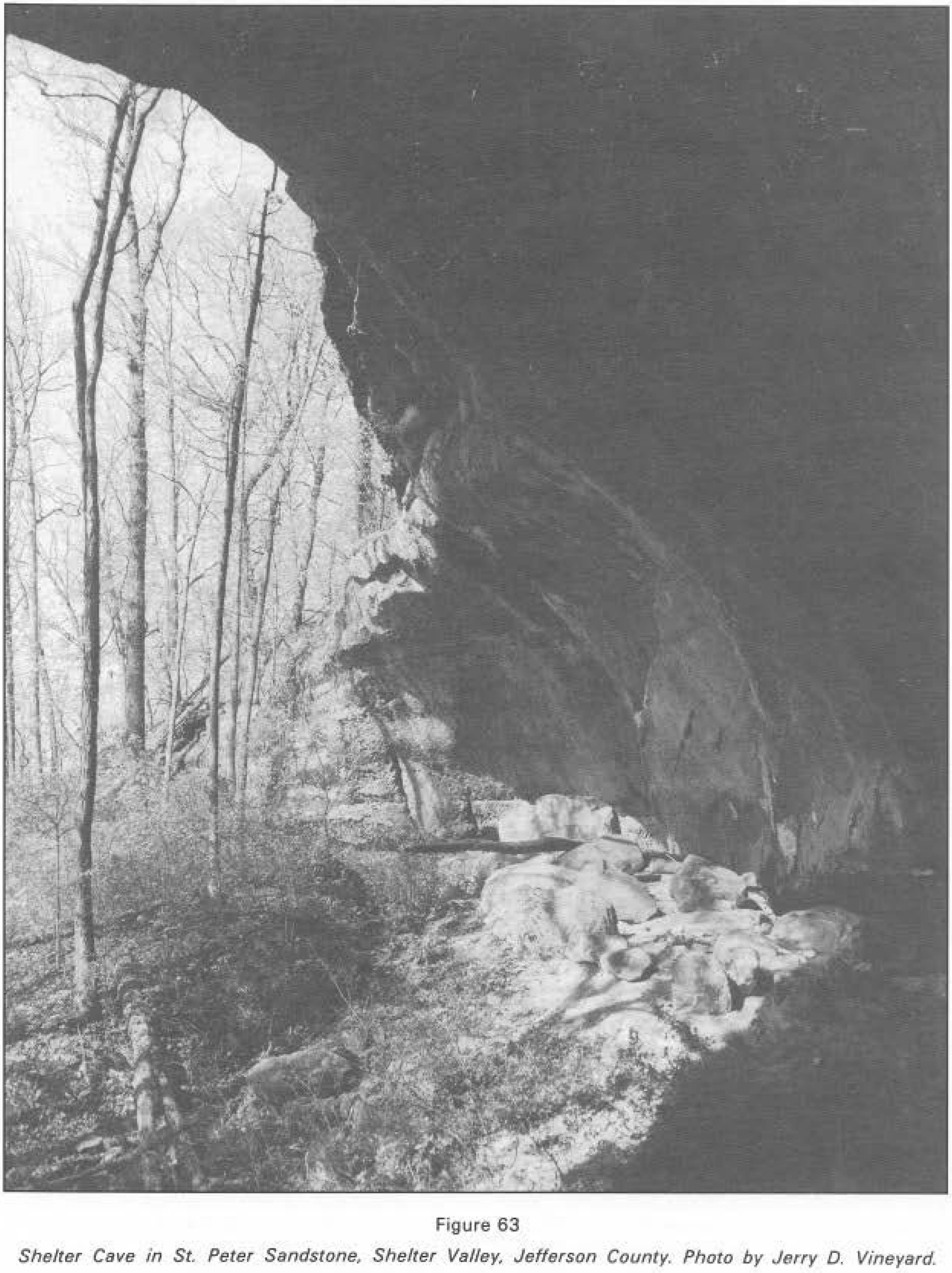


Figure 63

Shelter Cave in St. Peter Sandstone, Shelter Valley, Jefferson County. Photo by Jerry D. Vineyard.

147. TAVERN ROCK CAVE

Franklin County, 1.75 miles northeast of St. Albans, below railroad track in SW¼ NW¼ NE¼ sec. 35, T. 45 N., R. 2 E., Labadie 7½-minute Quadrangle.

On May 23, 1804, Captain Clark made the following entry in the journals of the Lewis and Clark Expedition (Thwaites, 1904, p. 27):

"We Set out early ran on a Log and detained one hour, proceeded the Course of Last night 2 miles to the mouth of Creek (R) on the Stb^d Side called Osage Womans R, about 30yds Wide, opposit a large Island and a (American) Settlement. (on this Creek 30 or 40 famlys are Settled, crossed to the Setlemt and took in R & Jos Fields who had been Sent to purchase Corn & Butter &c Many people Came to See us, we passed a large Cave on the Lb^d Side (Called by the french the Tavern[1] - about 120 feet wide 40 feet Deep & 20 feet high many different immages are Painted on the Rock at this place the Ind. & French pay omage. Many names are wrote on the rock, Stoped about one mile above for Cap' Lewis who had assended the Clifts which is at the Said Cave 300 fee(t) high, hanging over the waters, the water excessively Swift to day, We incamped below a Small Isld. in the Middle of the river, Sent out two hunters, one Killed a Deer.

Course & Distance 23rd May

S. 75 W 2 mils to Osage Wom^n R the Course of Last Night

S. 52 W 7 mil^s to a p^t on S^t Side.

This evening we examined the arms and ammunition found. those mens arms in the

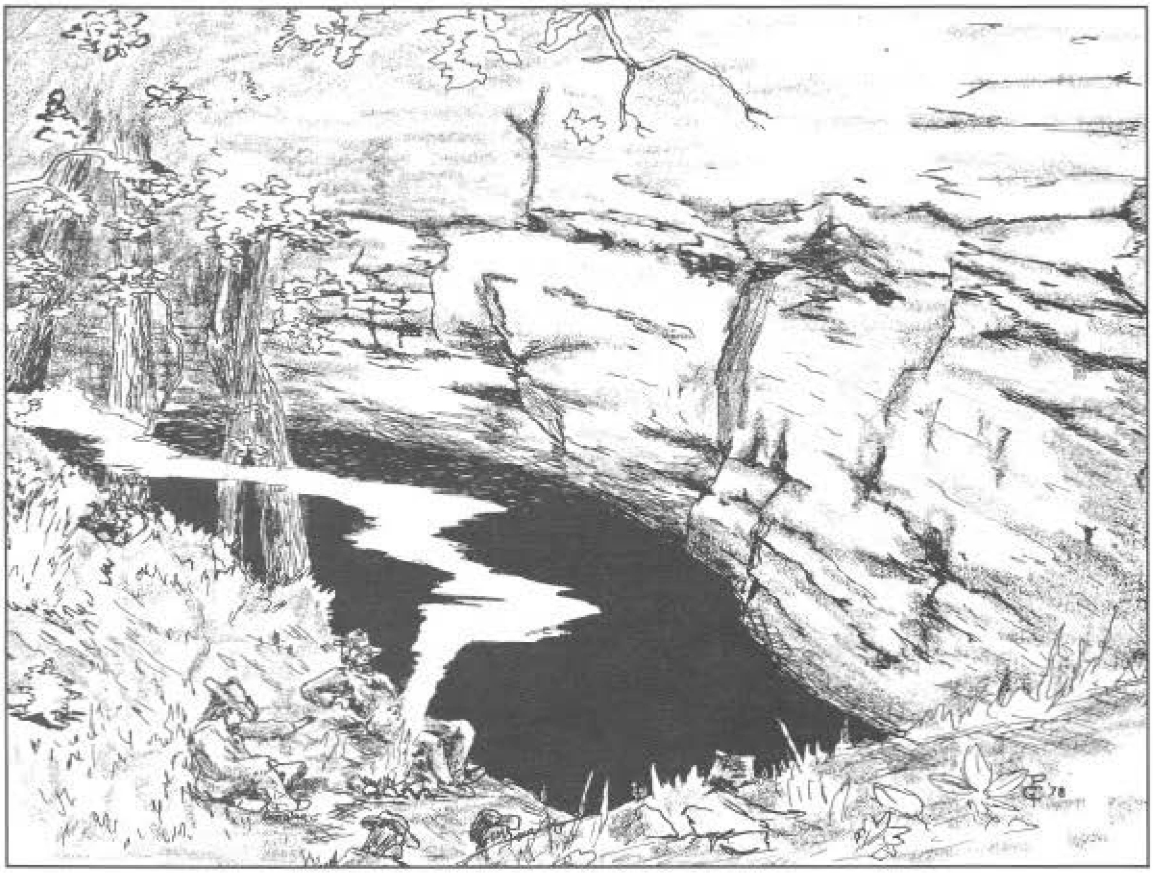


Figure 64

The Tavern Rock Cave area is described in the Lewis and Clark Journals. Drawing by Gary Clark.

perogue in bad order. a fair evening. Capt. Lewis near falling from the Pinecles of rocks 300 feet, he caught at 20 foot."

A footnote in the Lewis and Clark Journals (p. 27) states that Tavern Rock Cave was so named because it was a popular stopping place for voyagers on the Missouri River (fig. 64). A measurement of the dimensions shows Captain Clark's description to be quite accurate. The shelter is in the St. Peter Sandstone and exists as a result of selective weathering along a system of fractures which trend N 20° E or parallel to the bluff line. These fractures are obvious in the shelter because they have been enlarged by weathering to form narrow fissures in the walls and roof.

Numerous pits in the earthen floor suggest sufficient prehistoric occupancy has tempted artifact hunters. A casual inspection of the walls did not reveal any obvious Indian images. White man has left his initials but not in the expected profusion, probably because the shelter is remote and requires a bit of searching for the uninitiated.

Debris from the railroad cut was dumped in front of the cave and has partly obscured it. As a result, a photograph of the entire cave will not be particularly satisfactory until the happy day when this debris is removed to restore it to a semblance of its original appearance. Even though the site is not particularly rewarding to the photographer, it is sufficiently intriguing to justify a lengthy walk; no devotee of Lewis and Clark should miss the opportunity to visit this historic cave.

YOU CAN'T TAKE IT
WITH YOU,
SO LEAVE IT FOR
OTHERS TO ENJOY

The cave is most easily reached by walking along the railroad track from the community of St. Albans which, unfortunately, is not shown on most highway maps. It may be reached by going west from Highway 100 (Manchester Road) on Highway T opposite Rockwoods Reservation. The east entrance road to St. Albans is 3.7 miles off Highway 100 via a blacktop bearing right from Highway T. St. Albans may also be reached by taking Highway MM from Gray Summit, north to Labadie, and then following T northeast for 6 miles where a sign marks the turnoff to the left to St. Albans.

At St. Albans, park in the vicinity of the post office or general store and walk the railroad tracks to northeastward for 1.75 miles to a deep cut on the right with over 50 feet of dolomite exposed. This is the first deep cut encountered on the walk and is an excellent landmark. At the southwest edge of the deep cut, bear left (toward the river) down the steep slope from the railroad grade to the edge of the cave. Because of the walk involved, cool weather is preferable; the best view of the impressive bluffs and pinnacles mentioned by Captain Clark would be during the winter.

148. GRAHAM CAVE

Montgomery County, 2 miles west of Danville, on north side of I-70, in Graham Cave State Park, in NE¼ NE¼ SW¼ NW¼ sec. 27, T. 48 N., R. 6 W., Graham Cave 7½-minute Quadrangle.

Although the ground rules of this publication generally exclude detailed descriptions of caves, Graham Cave merits inclusion because it was not discussed by Bretz (1956), is an excellent example of a shelter with remarkable preservation of prehistoric cultures, and is the central motif of a state park. The cave is a huge arched opening (fig. 65) in the St. Peter Sandstone with a span at the excavated floor level of 60 feet and a maximum ceiling height at the front of 16 feet. Before archaeological excavations began, the maximum ceiling height was 6 to 8 feet (Klippel, 1971, p. 13). Excavation has removed sufficient fill material to permit walking about 60 feet back and, according to Klippel,

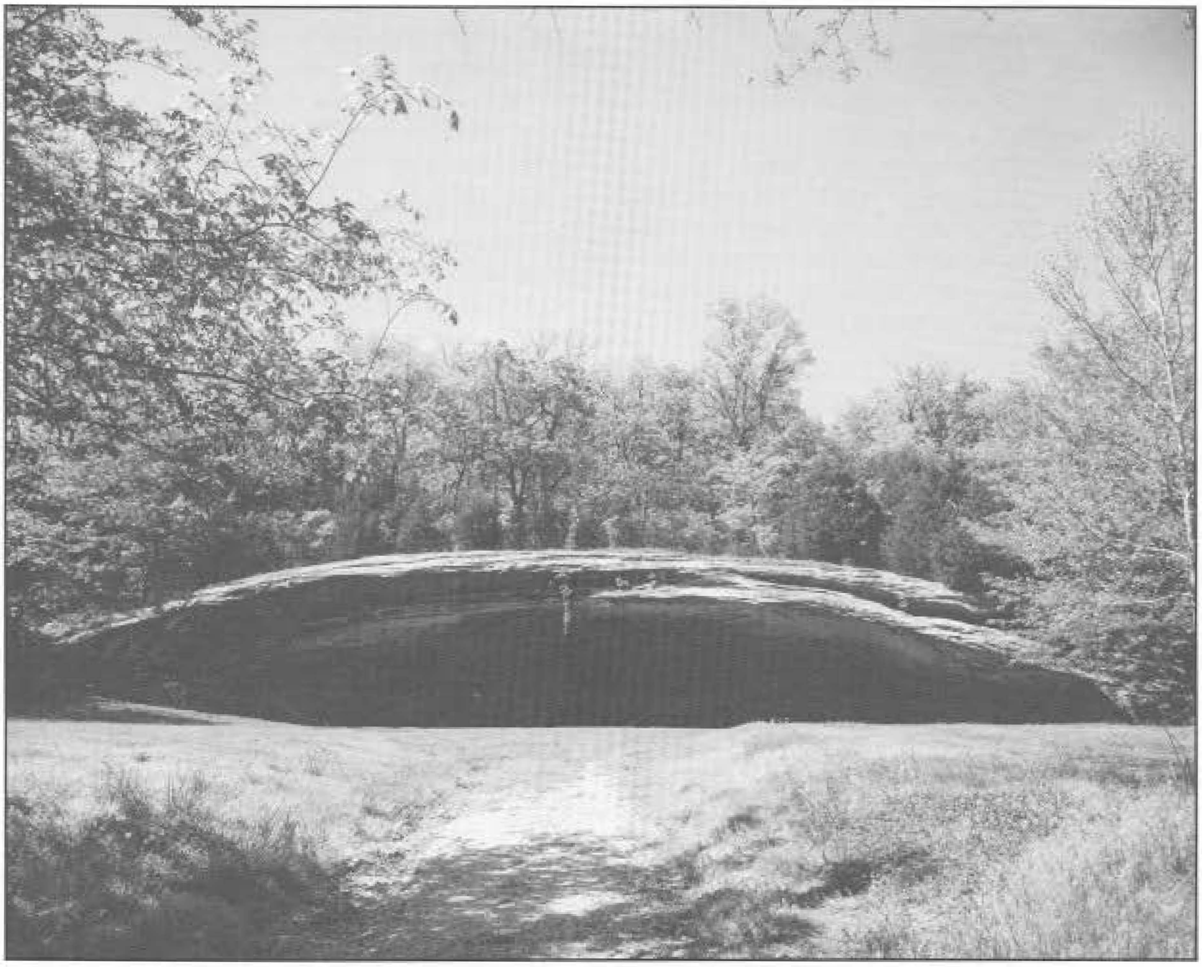


Figure 65

Graham Cave in Montgomery County (Graham Cave State Park) is in St. Peter Sandstone. Photo by Jerry D. Vineyard.

crawling for another 20 to 30 feet and seeing an additional 10 to 15 feet by using artificial light.

The excavation and research were conducted so that the remaining material is exhibited as natural levels representing three major zones of the Archaic Period, the oldest dating back to approximately 7850 BC and the youngest approximately 5950 BC. The origin of this type of cave may be debated; perhaps it is the result of differential weathering of a less strongly cemented sandstone exposed to freeze-thaw activities and percolating ground water. Another possibility would be the dissolving of underlying carbonate rocks permitting collapse of the sandstone into a void below. Regardless of its origin, the cave is most impressive and would be an excellent natural shelter for wintertime because of its southern exposure with a high entrance that permits efficient solar heating.

It may be photographed at any time of the year and during much of the day because it faces almost due south. A bit of its beauty has necessarily been sacrificed by a fence which protects the undisturbed fill from vandalism by artifact hunters.

Terry (1961) has outlined some of the modern history of the cave. It was purchased from Daniel Boone's son, Daniel Morgan Boone, in

1816 by the Graham family and remained in that family since that time with use as a shelter for livestock and farm implements. In 1945, bulldozing to enlarge the entrance for farm storage revealed such a plethora of artifacts that scientific excavation was begun by the University of Missouri in 1949. The cave was honored in 1961 by being designated a National Historic Landmark. It may be considered a site of beauty whether one's interests be archaeological, geological, or purely esthetic.

It is reached by taking TT west for 2.7 miles from the I-70 and Highway 161 interchange at the south edge of Danville. En route to the cave, the road passes a sign on the left labeled TWIN COPPERHEAD CANYON. This intriguing sign produced alternative interpretations. Is the canyon a twin? Is it a haven for twin copperheads? Fortunately a tight time schedule did not permit the necessary detailed research for interpreting this aspect of the sign.

149. ROCKHOUSE CAVE

St. Clair County, 3 miles southeast of Roscoe, in north bluff of Sac River, in SE¼ SW¼ NW¼ SE¼ sec. 28, T. 37 N., R. 26 W., Roscoe 7½-minute Quadrangle.

Caves, in general, have been excluded from this publication, but the following description of Rockhouse Cave by Hawksley (1972, p. 20) suggests inclusion as an unusual feature:

"Rockhouse Cave, on left, is a well known archaeological site which once yielded many artifacts. It is not a true cave but rather a roomed 'apartment house' weathered out of soft rock."

The following material is from the history of Henry and St. Clair Counties, Missouri (National Historical Company, 1883, p. 844-848):

"The cave contains a 'front room,' 30 feet wide by 40 or 50 feet long with a 20-foot ceiling, and was the winter home for Uncle John Whitley in the late-1830's. It was also the scene of a rather lengthy story regarding an alleged monster which terrorized the minds of the St. Clair County pioneers. In the spring of 1844, the first steamboat ascended the Osage River as far as Harmony Mission in Bates County. The steamer, the Flora Jones, had a steam whistle with a 'wild manic howl' which was misinterpreted as the howl of a monster. According to the report:

"There were no railroads at that day through this county, neither were there telegraph lines or telephones, there was nothing to herald the arrival of the monster but its own unearthly shriek, which was enough to blanch the cheeks of the bravest if he knew not what it was. It sounded like the wail of a lost soul."

One resident was *"...Plowing in his field, about a mile or a little more from the river, when that unearthly shriek struck his ears. His hair stood on end, his face blanched and his horse was about as bad off. He unhitched it, and managing to get on its back, notwithstanding both being stricken with terror, he was about to start to his cabin to bar himself from the savage beast when another shriek struck him. That was enough, horse and man lit out, and in one hour were in Papinville, fifteen miles distance, the horse white with foam and Arbuckle white with terror."*

All the neighbors were aroused and a hunt was launched to kill the terrible animal with the hunters congregating at Uncle John Whitley's home. While they were searching for the monster, a storm broke and they took refuge in Whitley's former winter home, Rockhouse.

The description of their efforts continues, stating:

"After their supper a guard was placed at the mouth of the cave, to prevent the monster, should he be lying around, from entering the cave until the rest of the band had been aroused. As the gray of the morning began to appear and

BEHAVE SO
PROPERTY OWNERS
WILL WELCOME YOU
BACK.

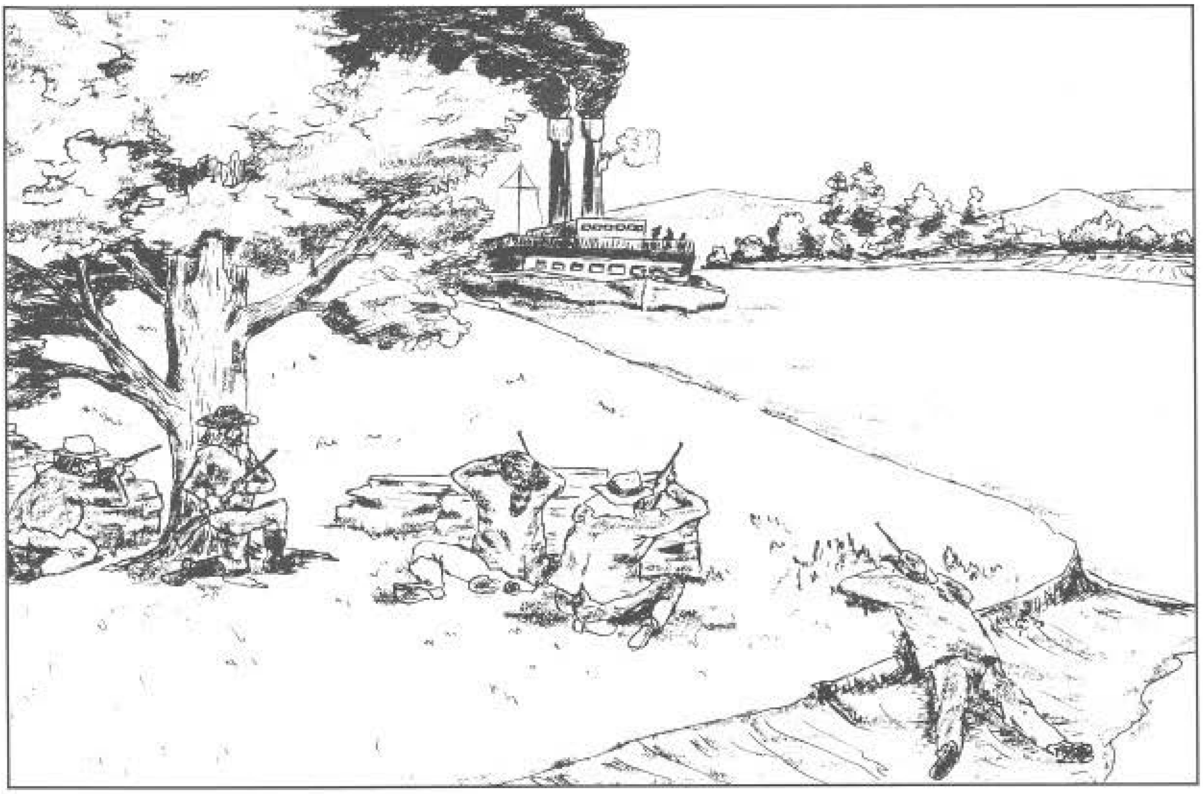


Figure 66

The Rockhouse Cave area in St. Clair County was the scene of a "monster hunt" in 1844. Residents thought the steam whistle of the first steamboat to ascend the Osage River was the howl of a monster ... and the "hunt" was on! Drawing by Gary Clark.

the eastern sky took on its crimson blush, came also the shrill shriek of the monster, and then ending in a roar which seemed to make the floors tremble and the cave re-echoed its sound to the excited minds of the hunters. A council of war was held, and while some thought a short-cut for home was about as safe a plan as could be suggested, Uncle John Whitley and Uncle Jimmy Breckenridge were for standing their ground, in fact, going out to meet their dread fore, and fight to the death. This was decided on. The monster was still roaring, and was coming nearer and nearer until they could actually hear him puffing and blowing, while making his way along the river bank, apparently close to the water.

"The moment of decisive action had come. The monster had given one unearthly shriek and roar, and was coming right down the river bank, and they must meet him. They at once took up their march for the river, and it must be said with blanched cheeks, but their nerves had been strung, and they had sworn together to take that beast dead or alive, or it would take them. They got close to the river bank, and each man selected his tree and made ready as they heard the monster coming around the bend not more than a hundred yards from where they had taken up their position (fig. 66). All at once the Flora shot in view, and upon her deck were a gay throng of passengers, apparently watching the sunrise and making the time pass merrily.

"Their senses came to them at last, and not a word was said or a funeral note at the grave where their foe had perished, but being entirely too full of utterance, each of these gallant men, quietly and unostentatiously and with sadness of mein [sic], sought the privacy of their cabins, and thus ended the hunt after the monster of mountains of the Osage Valley."

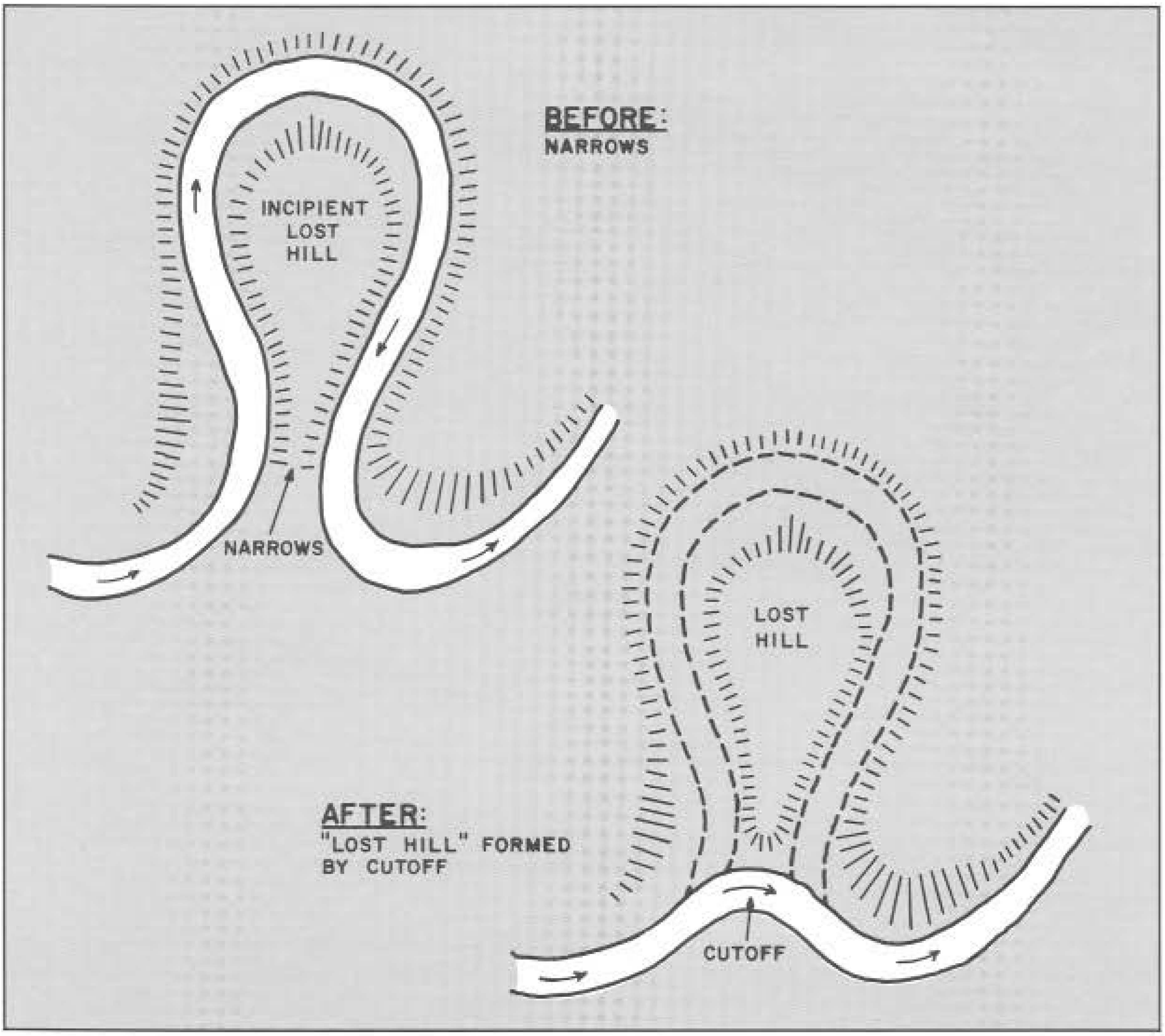

BEFORE:
NARROWS
INCIPIENT LOST HILL
NARROWS
AFTER:
"LOST HILL" FORMED BY CUTOFF
LOST HILL
CUTOFF

Figure 67

"Narrows" and "lost hills" in entrenched meander environment.

6

Narrows, Cutoffs, and Lost Hills

As used in Missouri, the term "Narrows" generally refers to a very sharp ridge between two streams or sinuous valleys of the same stream. Exceptions to this statement are localities 157 where the term is used for a constricted stream valley and 159 where it refers to a timber pattern.

The origin of all of the Missouri ridge narrows is the same; they exist where stream erosion has left a very narrow ridge behind. In some cases the erosion is the product of two parallel streams; in others, erosion in a stream meander loop deeply cut into bedrock has left a very narrow neck or "narrows." Where a stream finally erodes through this neck and thus shortens itself, a rock land island, commonly called a "lost hill" is left behind (fig. 67). Such lost hills are common in the drainage systems of all of the Ozark streams with entrenched meanders as well as in the southern Appalachians from whence the term was imported by early Ozark settlers.

As streams age, they tend to deviate from a relatively straight course and develop meanders — S-shaped curves exemplified by the Mississippi River as it wanders over its floodplain. In some cases, the streams develop a very intricate meander system and may cut through the necks of loops to shorten themselves. The most common environment for such stream patterns is where broad floodplains have been developed and the stream has had a relatively lengthy geologic history. In *Life on the Mississippi,* Chapter XVII, Mark Twain, with a bit of tongue-in-the-cheek lower mathematics, "proved" that the Mississippi shortened itself by 242 miles in 176 years by cutoffs and that by the year 2616, New Orleans, Louisiana, and Cairo, Illinois will be neighbors.

Missouri, especially the Ozark portion, contains many streams which have exceptionally crooked paths reminiscent of the Mississippi. Yet, instead of flowing on a broad floodplain some of the major streams have relatively narrow floodplains with steep bluffs on the outside of bends and floodplains and gentle slopes on the inside of bends. This combination of exceptionally sinuous paths and a lack of broad floodplains is not explained by a single hypothesis with which all geologists concur. Such streams are generally called entrenched streams.

One hypothesis for entrenched streams holds that the Ozarks were worn down to a plain of low relief at some time in the geologic past, creating a low-relief landform known as a peneplain. In such an environment, major streams would develop broad floodplains and the sinuous paths typical of large streams with a relatively long erosional history.

Subsequent uplift of the peneplain area would result in the rivers being rejuvenated and renewing very active downcutting typical of the earlier stage of development, yet following the exceptionally crooked paths typical of their advanced age in a peneplain environment. This combination of events would result in the so-called entrenched meanders with the lack of a major associated floodplain.

Another hypothesis would hold that the streams from their inception have had a somewhat crooked path and that the crookedness has been accentuated by the tendency of the stream to migrate to the outside of bends, thus enlarging the radius of the loop.

A third hypothesis is that some streams followed paths determined by vertical fracture systems forming zones of weakness in which valleys could be developed. Commonly such near-vertical fractures are in groups parallel to one another and also may contain another group of parallel fractures at approximately right angles to the first group (fig. 68). Intersection of these two systems would tend to produce a somewhat rectangular grid pattern and streams following this grid would have exceptionally crooked courses modified by subsequent erosion to eliminate the angular corners and to produce entrenched "meanders."

Nearly all of the major Ozarks streams are entrenched and some tend to have paths which are so geometric that they support the fracture control hypothesis (fig. 69). An excellent example of an exceptionally crooked stream which appears to have such a rectangular pattern is the Bourbeuse River in Franklin County, south and southeast of Leslie and Beaufort as shown on the Leslie and Spring Bluff 7½-minute Quadrangles. Exceptionally straight bluff lines on many of the major streams suggest that these lines were determined by fracture zones and the drainage patterns of smaller tributaries. For example, those of the Big Piney in northern Texas County and southern Pulaski County in the extreme south-central and northeastern parts of the Slabtown Spring 7½-minute Quadrangle support this concept.

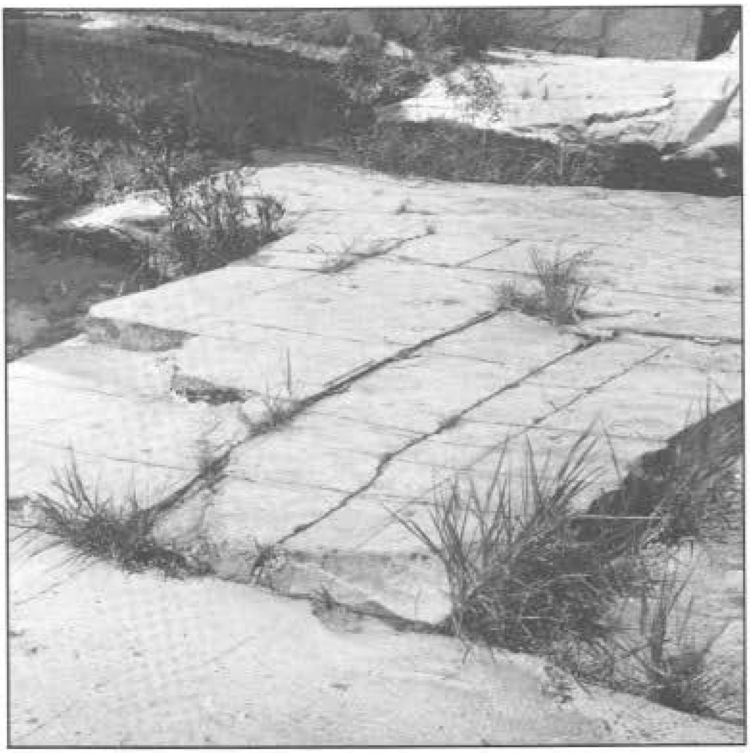


Figure 68

Jointing or vertical fractures in bedrock, near Ironton. Photo by David Hoffman.

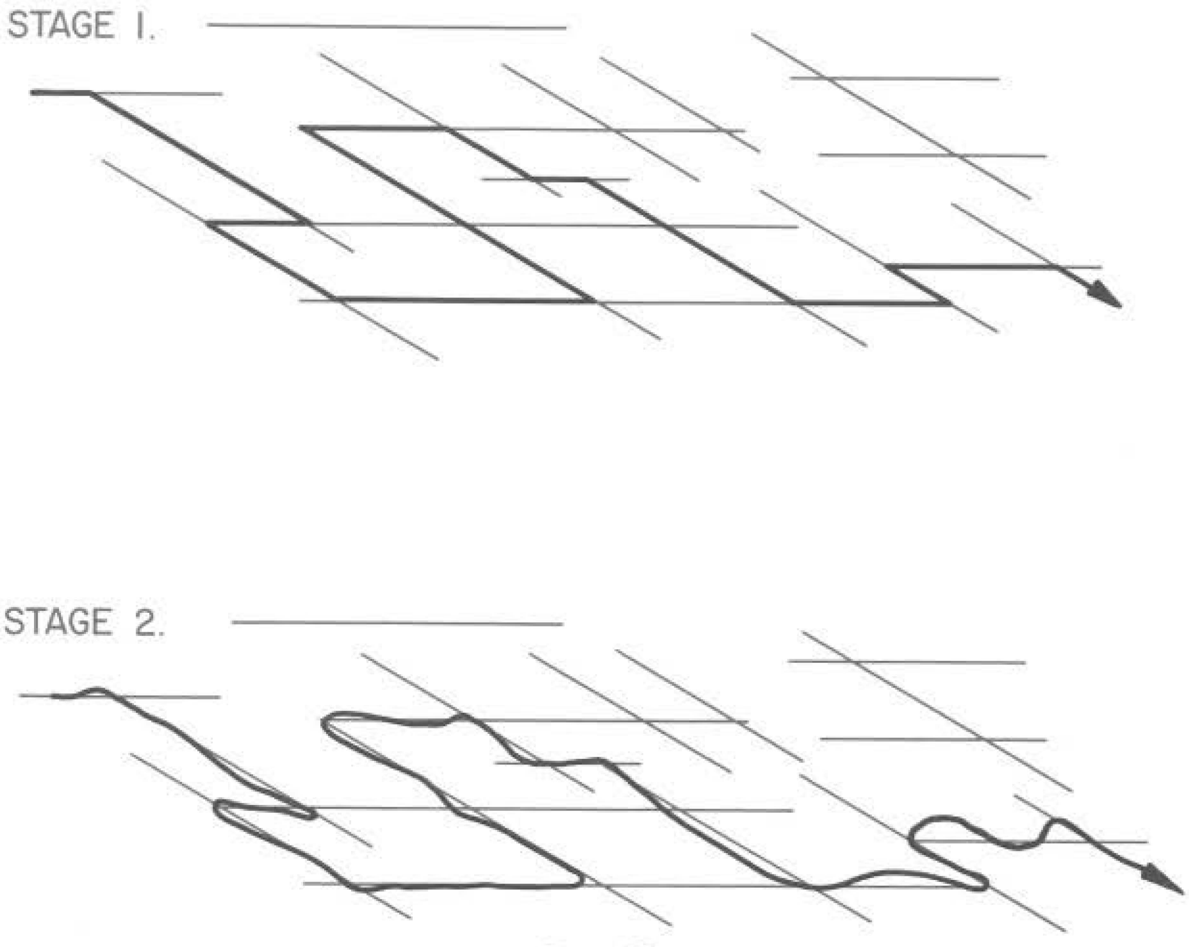


Figure 69

Crooked stream paths derived from fracture control.

150. THE NARROWS (BALANCING ROCK)

Texas County, 3 miles west of Houston, in center W½ sec. 11, T. 30 N., R. 10 W., Bucyrus 7½-minute Quadrangle (shown as part of Piney River Narrows State Natural Area).

The Narrows is also known as the Balancing Rock because, as seen in end view or cross section, this ridge has a T-profile. However, it changes longitudinally from a well-anchored T- or I-beam to a normal, well balanced but still attractive, exceptionally narrow ridge. Many of the "narrows" in Missouri are crowned by roads. The Houston specimen is too narrow for a road but it is one of the most scenic.

The ridge is formed by erosion of West Piney Creek and Big Piney River which almost sideswipe one another with The Narrows remaining as a rock divide so narrow that within the short time of a few thousand years one of the streams will probably breach the rock barrier or median to form a cutoff. The rock in the spectacular pinnacled crest of The Narrows is the Jefferson City Dolomite. The resistant cap is formed by the "Quarry Ledge" unit of the Jefferson City. This ledge, which can be traced through many counties of the central Missouri Ozarks, is a thick-bedded, pitted dolomite which was a popular dimension stone in the days of hand labor and plentiful, skilled stonemasons. Many of the old buildings from Houston north through Rolla, Vienna, and Westphalia have been constructed with walls and/or foundations from the Quarry Ledge.

At the southeast end of The Narrows, the Quarry Ledge cap is 8 feet thick and 25 feet wide. This cap is underlain by thinner-bedded, less resistant cherty dolomites which have been eroded to form a pedestal 4 feet high and only 3 feet wide. This southeast extremity of The Narrows pinnacle is the often-photographed Balancing Rock. The pinnacle is 70 feet long and has less overhang but is easier to photograph on its northeastern end. The exceptionally narrow pinnacled crest of The Narrows is nearly 200 yards long and the visitor has a variety of paths atop or on the northeast flank of the ridge.

Cedars (junipers) love dolomites, especially those of the Quarry Ledge, and their affection is obvious at The Narrows. In many other areas to the north from Houston, cedar groves are excellent markers indicating that the pitted dolomites of the Quarry Ledge are at or close to the surface. In contrast, pines love sandy, acid soils. Sandstones of the Roubidoux Formation, which form the lowest part of The Narrows, are widespread in Texas County and support the great stands of pine which were the namesakes for the Big Piney River.

The Roubidoux is well exposed in the bluff of Big Piney River at Dogs Bluff Public Fishing Access of the Missouri Department of Conservation, a mile northeast on Highway 17 and 0.5 mile north of the junction of Highways 17 and Z. A visit to The Narrows is not complete without a stop at Dogs Bluff and vice versa!

From the junction of Missouri Highway 17 and U.S. Highway 63 at Houston, The Narrows are reached as follows:

Take Highway 17 west (north) for 2.5 miles and turn left (south) onto Highway Z. Cross Big Piney Bridge on Z and park on the right side of highway, at first parking pullout. Climb fence and follow path northwestward to where trail drops down. Follow trail along right-hand side of Narrows for 70 yards more and you are at the Balancing Rock.

151. DEVILS BACKBONE AND NARROWS (AKERS)

Shannon County, on Highway K at Akers, between Salem and Summersville, in E½ sec. 14, T. 31 N., R. 6 W., Cedar Grove 7½-minute Quadrangle (fig. 70).

The Devils Backbone at Akers is the narrowest narrows utilized by a Missouri State highway and undoubtedly is a nightmare rather than a dream for those operating power-mowing equipment on the steep slopes as much as 250 feet above the flanking streams. This ridge was formed by erosion of the Current River creating a steep bluff on the west side and a tributary to the Current, Gladden Creek, developing a matching steep bluff on the outside of a meander loop on the east side. It is called the Devils Backbone locally, has been called The Narrows by some, and has dual names to others!

In addition to the view of the two valleys from this topographic razorback, there is the enjoyable trip on the Akers Ferry across the Current River and if time permits, a stop at a Roubidoux sandstone quarry 2 miles south of the ferry is rewarding. At this quarry*, sandstone, case-hardened by thousands of years of exposure to the weather, is produced for dimension and facing stone. Some of the sandstone has excellent preservations of ripple marks which record evidence of the shallow water seas in which it was originally deposited. A full day would include the Sunkland (No. 204), 3 miles south of the ferry.

A great variety of routes could be used to reach the Devils Backbone but the most spectacular view is along Highway K through pine forests south to Akers, overlooking the valley system. In addition to the features cited, Devils Well, The Sinks, Round Spring, and Montauk State Park are all in the general area. Of the drivable narrows in Missouri this is a favorite, not only because of the view but because of the variety of other enjoyable features. The drive is most rewarding in the winter when foliage does not obscure the view (fig. 182 on page 341).

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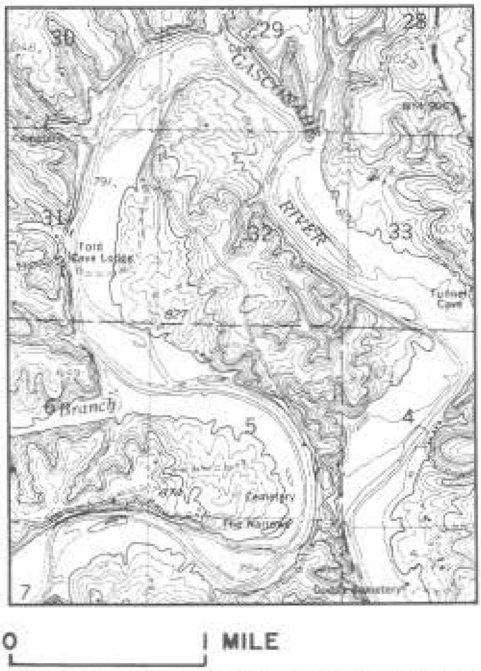
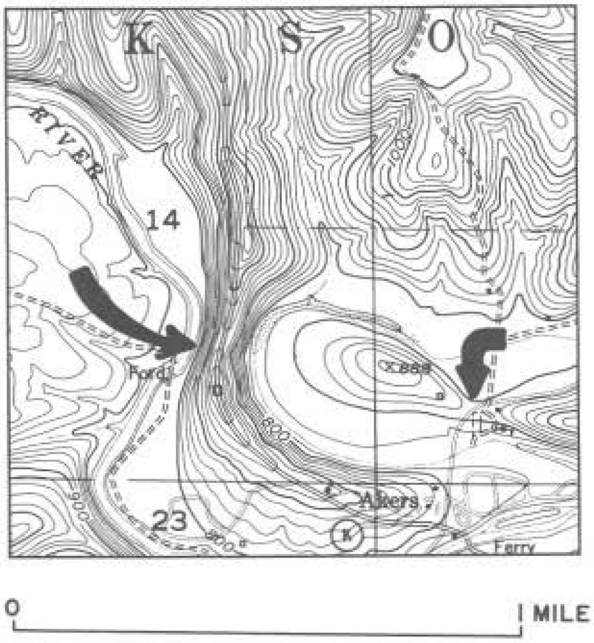
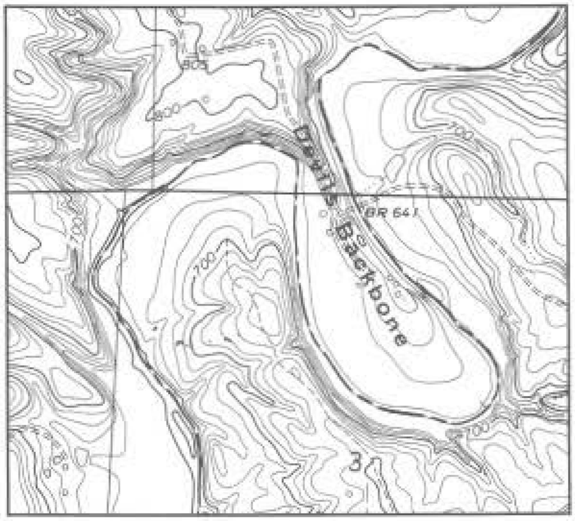
*Quarry is no longer operating (1983).


30
29
28
GASCONADE
RIVER
31
Ford Cave Lodge
32
33
Tunnel Cave
827
6
Branch
5
4
Cemetery
The Narrows
7
0
1 MILE

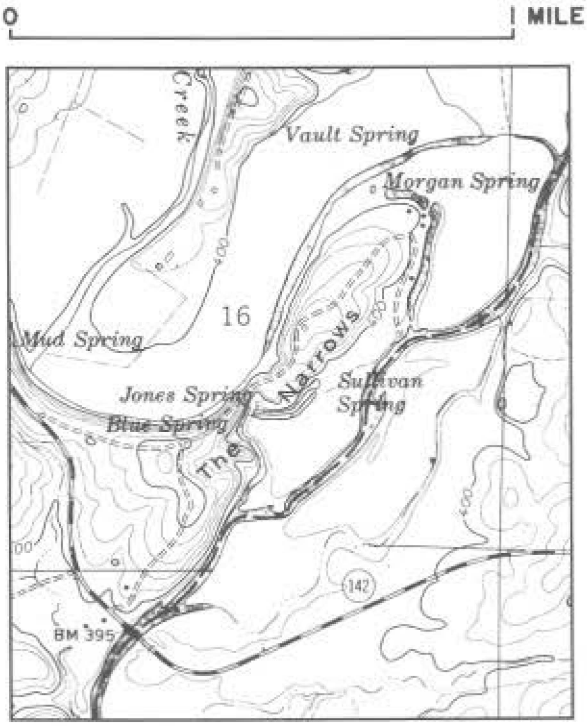
There are many narrows along the winding Gasconade River. This one separates a "moccasin bend" loop in the river southwest of Crocker. Richland 15-minute Quadrangle.


K
S
O
RIVER
14
Ford
868
800
Akers
23
Ferry
0
1 MILE

There are two Narrows near Akers — one large, the other small. Cedar Grove 7½-minute Quadrangle.


800
Devils Backbone
BR 641
700
3

What's in a name? Devils Backbone and Narrows are genetically the same. The Backbone above is in Boone County. Millersburg SW 7½-minute Quadrangle.


0
1 MILE
Creek
Vault Spring
Morgan Spring
16
Mud Spring
Jones Spring
Blue Spring
The Narrows
Sullivan Spring
142
BM 395
400

Narrows may be associated with other interesting features, as the six springs near The Narrows on Frederick Creek. Billmore 7½-minute Quadrangle.

Figure 70

Topographic maps from U.S. Geological Survey showing several narrows.

152. THE NARROWS (ELEVEN POINT RIVER)

Oregon County, on Eleven Point River, near Highway 14 bridge, midway between Doniphan and Thayer, in sec. 16, T. 22 N., R. 2 W., Billmore 7½-minute Quadrangle (fig. 70).

This 100-foot-high ridge separating the Eleven Point River and Frederick Creek has recently become part of the Eleven Point National River administered by the U.S. Forest Service. A very narrow road following it, flanked by a steep bluff below on the northwest side and craggy blocks above on the northeast side, guarantees alert driving and perhaps some acrophobia. At the time the road was driven, it was approximately three-quarters of a lane.

The general area is well worth visiting because of the several major springs in the area including Blue Spring, Sullivan Spring, Gilman Spring, and Morgan Spring. Morgan Spring once supplied water for the largest aquatic farm in the United States, specializing in mosses and similar materials for aquariums.

According to Aley (1969, p. 163-164), fluorescein dye introduced into a sinkhole used as a dump near Alton appeared 2.5 to 3 months later at Morgan Spring, 15.5 miles away. At the time of writing, the Blue Spring area is in the stage of development reached while in private ownership — a very tasteful development which preserved the environment well. Undoubtedly further facilities will be added as it becomes a public use area.

IF A HILL CAN GET LOST,
SO CAN YOU...

Because of its nearness to Highway 142, with an entrance on the north side of the highway immediately west of the bridge over the Eleven Point, Blue Spring certainly merits a visit by anyone in the general area.

Reports of a natural bridge in the area could not be confirmed but the large number of springs and other karst phenomena in the area suggests that the probability of one is quite high.

153. THE NARROWS (CALLAWAY COUNTY)

(JDV)

Callaway County, on Highway O, 5 miles west-northwest of Reform, in SE¼ NW¼ sec. 6, T. 46 N., R. 8 W., Reform 7½-minute Quadrangle.

The Narrows is dominated by an imposing sandstone erosional remnant (the Rock) that rises 60 feet from the water's edge on Crow's Creek; its flanks are cut by trails and the top scarred by the spoor of the tourist, *Homo boobiensis.* The popularity of the place is attested by the spent shell casings, the nonbiodegradable drink cans, tab tops, and cigarette butts. Any loose stones on the top of the Rock have long since been thrown into the creek below, thereby accelerating the natural rate of erosion of a rock prominence such as this.

The Rock is probably a sink filling derived from St. Peter Sandstone. It is highly cross-bedded, as these paleokarst sink fillings usually are, and its sides are deeply sculpted and pitted by solution-erosion. The south side of the Rock is split by a huge crack, wider at the top than at the bottom, indicating that about the south quarter of the Rock is slowly edging toward the river, like a natural "leaning Tower of Pisa."

The craggy sides of the Rock provide cozy niches for ferns; mosses and lichens cover moist and other favorable growing areas on its face. Wherever there is any thin soil, cedars gain a toehold, for they love sandstone. A few struggling oaks, some maples, and a few other plant species share the meager ground on the flanks and crown of the Rock.

The origin of the structure as a filled sink is apparent from studying the rock outcrop along the road where Highway O cuts through a peninsula-like ridge separating two creeks, of which The Narrows is the most prominent part. The roadcut shows horizontally the strata of the Jefferson City-Cotter Formation, but the east end of the cut goes through what must be an extension of the ancient filled-sink structure. In this part of the cut, steeply dipping sandstone beds are inclined 35° to 40° toward the Rock. In the western part of the sandstone beds, the margin of the ancient sink can be seen, with sandstone beds and filled-sink deposits resting unconformably against the undisturbed dolomite.

Photography is difficult at best, but on a warm spring morning patience will be rewarded by climbing down to the north bank of the creek, and walking south until one gets a viewfinder-filling view. In the summer, the Rock is mostly obscured by vegetation.

The Rock does not show on the Reform 7½-minute Quadrangle, even though it is over 60 feet high and there is a 20-foot contour interval. The reason may be that it is small, yet certainly large enough to make an imposing sight; it makes an interesting part of the local scenery.

154. THE NARROWS (NORTH FORK SALT RIVER)

Monroe County, 5 miles north of Goss, near center common line secs. 4 and 5, T. 55 N., R. 9 W., Goss 7½-minute Quadrangle.

This site was not visited. According to the topographic map, a half-mile walk would be the minimum distance required for reaching it. The Narrows was formed by meander loops of North Fork Salt River and its tributary, Crooked Creek, approaching one another so closely that the divide between the two is only a hundred yards wide at its base and thins to a very narrow crest. The crest is from 50 to 75 feet above the stream valleys and is a quarter of a mile long.

In a few thousand years, the divide will probably be breached and Crooked Creek will be shortened by 2 miles as it joins North Fork Salt River that distance upstream from its present junction. Sections 4 and 5 are 2 miles long, a not uncommon exaggeration in the top tier of sections in a township.

155. CAVE HILL NARROWS

Cape Girardeau County, 1.5 miles north-northwest of Burfordville, in N½ sec. 10 (projected), T. 31 N., R. 11 E., Millersville 7½-minute Quadrangle, on which it is named.

Curiously, this excellent example of a narrows is simply named Cave Hill on the topographic map (fig. 71). It is formed by Whitewater River and Schroder Branch as their adjacent valleys erode ever closer.

As a textbook example of how lost hills form, Cave Hill Narrows would be hard to top.

156. THE NARROWS (BRYANT CREEK)

Ozark County, on Bryant Creek, 2 miles south of Sycamore, on line between secs. 10 and 15, T. 23 N., R. 12 W., Sycamore 7½-minute Quadrangle.

This site was not visited. The topographic map shows the ridge as a short neck between two loops of Bryant Creek, rising nearly 200 feet above the valley. The visitor might also need a Cureall NW 7½-minute Quadrangle map to reach the site. According to the Sycamore Quadrangle, a private, dead-end road follows The Narrows.

Hodgson Mill and Spring on Highway 181 upstream near Sycamore make the area especially appealing, for this is an active mill renowned for its stone buhr-ground products.

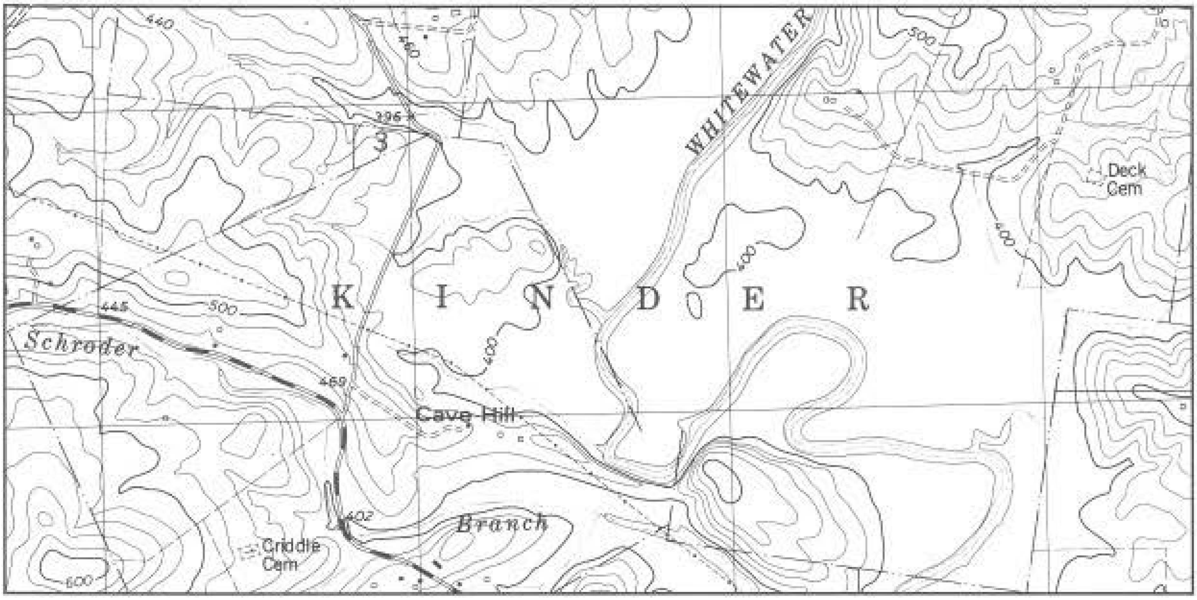


Figure 71

Narrows form where separate streams, in the course of deepening and widening their valleys, encroach upon one another. Here, Whitewater River on the North and Schroder Branch on the south together have formed a narrows between them. Whitewater River is the more aggressive of the two, and it has almost breached the narrows. When it does, the hill on the east end of the narrows will become a "lost hill," Schroder Branch downstream from the breach will become a "lost valley," and Schroder Branch will be called a "beheaded stream."

157. CRAWFORD COUNTY NARROWS

Crawford County, 9 miles east of Steelville, Upper Narrows and Lower Narrows named on Huzzah 7½-minute Quadrangle; The Narrows on Onondaga Cave 7½-minute Quadrangle.

Within a distance of 3 miles, three sets of narrows are developed along Huzzah Creek. The Upper Narrows is immediately south of Highway 8 on the west side of the Huzzah in sec. 36, the Lower Narrows on the east side of the Huzzah in sec. 24, and The Narrows on the east side of the Huzzah separating it from the Courtois in sec. 13, all in T. 38 N., R. 3 W.

The origin of the name "Huzzah" is discussed under No. 271. The pronunciation of Courtois is always baffling to newcomers but it is generally "Cote-away" or "Code-away," demonstrating that a language can become a bit distorted after 200 years of isolation from its native land.

This area was topographically significant in the very decisive Fort Davidson battle and withdrawal at the town of Pilot Knob in September 1864. General Ewing's Union troops successfully evacuated Fort Davidson under cover of darkness despite being completely surrounded and outnumbered by Confederate troops. The forced march from the fort near Ironton to Leasburg east of Cuba covered 66 miles and took only 39 hours. General Ewing in his official report states that he chose the route along the Courtois and Huzzah because it:

"...led nearly all the way along a sharp spur of the Ozark range, separating the waters of the Huzzah and the Courtois, and through the gorge of the Huzzah, walled in with untraversable cliffs, to Rolla was fifty-five miles, to Harrison (Leasburg) thirty-five." (Ewing, 1893, p. 449-450).

(Note: If this sentence appears awkward, remember that the General had been under some nervous strain!).

The entire march was over very rough country with a thousand troops and a mixture of infantry, cavalry, and artillery and numerous rear-guard skirmishes during the retreat. Although crossing the rugged terrain was the major problem, the utilization of the divide between the Courtois and Huzzah minimized the danger of flanking attacks. Probably these troops were especially appreciative of The Narrows!

Hawksley (1972, p. 59) also uses the term "Narrows" to describe a narrow, fast section of Courtois Creek, 3 miles upstream from its junction with Huzzah Creek.

158. THE NARROWS (GASCONADE RIVER)

Pulaski County, 6 miles northwest of Waynesville, on Gasconade River, in sec. 5, T. 36 N., R. 12 W., Ozark Springs and Crocker 7½-minute Quadrangles.

At this narrows, the river distance of slightly over 7 miles contrasts with a beeline distance of less than 0.2 mile across the rock ridge at the neck of the great loop. This is an example of a typical Ozark stream meander loop which is impressive on the topographic map but is not particularly so on the ground. The ridge is not unusually narrow at the crest and the timber is too thick to provide the double-flanking scenery visible from some of the narrower narrows.

159. GRAND NARROWS

Macon County, between Macon and Jacksonville, east of Highway 63, Macon NW 7½-minute Quadrangle.

According to Campbell (1874, p. 33), the Grand Narrows area in Macon County is named from a "peculiar opening in the timber bordering the prairie." Thus Narrows Creek and Narrows Township appear to owe their names to a phenomenon of flora rather than geology.

160. GRAND PASS DIVIDE

Saline County, along Highway 65, between 1 and 2 miles east of the town of Grand Pass, in S½ secs. 22 and 23, T. 51 N., R. 23 W., Grand Pass 7½-minute Quadrangle.

This divide between Salt Fork and the Missouri River was followed by the Santa Fe Trail if it is defined as starting as far east as Arrow Rock. The base of the divide at floodplain level of the two streams is a minimum of 270 yards wide; thus the crest is much narrower and the proximity of the two valleys is described by Meek (1873, p. 158-159) as follows:

"It is a little remarkable that this stream approaches so near the Missouri Valley at Grand Pass, in the northwestern part of the county, that it could be turned into it, if desirable, by a canal not more than about 35 feet deep and 150 to 200 yards long, and yet afterward turns and flows across the interior, where the country must rise at some places as much as 140 feet above its valley on each side.

"At the narrow point mentioned above, there is a low place where water appears to have flowed across at some time, either from the Salt Fork into the Missouri Valley, or from the Missouri into the Salt Fork. As it seems scarcely possible so small a stream as the latter could ever have been swollen to such an extent as to flow through this gap, I am inclined to the opinion that at some extraordinary freshlet the Missouri broke over this barrier, and some of its water found an outlet down through the valley of the Salt Fork into the Blackwater, and thence out through the Lamine below into its own valley again.

"I was informed that during the great flood of 1844 the Missouri only rose to within about 25 feet of the lowest part of this gap; consequently, if it ever did break over here, it must have been when at a much greater hight [sic] *than it is now subject to obtain, or perhaps ever will do again, as it has probably deepened its channel some, and may have acquired an increased velocity of current in consequence of a gradual rise of the country, even within a few hundred years past."*

In 1875, water crossing this divide was described as follows (Missouri Historical Company, 1881, p. 115):

> *"During the unusual freshlet of 1875, Salt Fork broke over at the lower portion of this divide of the Grand Pass, and for several days a large part of the surplus waters of the creek flowed into the small lakes or ponds, with which the Missouri River here abounds. No channel was cut, however, through the divide, and when the waters subsided, the bed of the creek and the Grand Pass resumed their former position, aspect, and relation to each other."*

Another breakthrough in 1905 is photographically documented by Orr (1967, p. 181).

The Baltimore Thomas Hume home, built in 1867, and located 1.5 miles west of Grand Pass, is a nine-room brick dwelling with cherry and walnut paneling. It has been designated as a Historical Site.

161. GRAND DIVIDE

Nineteenth Century descriptions of northeastern Missouri commonly referred to the Grand Divide, the divide separating drainage into the Chariton and Little Chariton on the west and the Fabius and Salt basins on the east. This divide is followed quite closely by U.S. Highway 63 from the Iowa line south to Moberly. Most of the drainage on the west side of the highway goes into the Missouri River and that on the east side into the Mississippi upstream from Louisiana. This is not a "Narrows."

NO TRESPASSING
SIGNS FOLLOW RUDE AND
UNTHINKING VISITORS...
DON'T BE A "JOHNNY
SIGN - SEEDER"

162. DEVILS BACKBONE (BOONE COUNTY)

Boone County, 12 miles southeast of Columbia, on west side of Cedar Creek, in SW¼ SE¼ SW¼ sec. 34, T. 47 N., R. 11 W., extending into center N½ N½ sec. 3, T. 46 N., R. 11 W., Millersburg SW 7½-minute Quadrangle (fig. 70).

This Devils Backbone is impressive on the ground as well as from the air and provided ample scenic reward for a fishtailing drive on muddy roads as well as the challenge of a turn-around at the Backbone with mud on one side and a steep bluff on the other. The ridge is 0.5 mile long. The most scenic portion is on the upper part where it is but a few yards wide at the crest with room only for a very rough limestone ledge road leading to the bottomlands. At the parking area this narrow ridge is 170 feet or more above the streambed with an excellent view which would be most impressive during the fall coloration season.

The Backbone is formed as a rock neck in a meander loop of Cedar Creek. A saddle in the middle of this neck suggests that sometime in the geologic future Cedar Creek will take advantage of this lower part and cut through the neck to leave its tip as a lost hill.

The rock in the Backbone is Burlington Limestone containing many crinoids; fragments of these button-like fossils have weathered out so that they may be easily collected. Many of them are hollow in the center and thus ideal for stringing to make Indian beads or wampum.

This site has two disadvantages. The first attempt to reach it was from the east side of Cedar Creek using the bridge shown on the map; however, the bridge is abandoned and cannot be driven on although one probably could do a bit of high steel walking where planks are rotten or missing. The other disadvantages are the final 0.75 mile of dirt road which can be quite slippery in wet weather, as well as the turn-around at the parking area. The site was reached via the following route:

Miles

0.0 *Junction of Highways 63 and H, 4 miles south of Columbia. Drive east on H past Columbia Regional Airport turnoff, staying on H.*

4.15 *At Englewood, continue straight ahead on road which angles slightly to the right.*

5.4 *T-junction, continue straight ahead.*

5.95 *T-junction, turn right (south) and follow winding road.*

7.1 *At parking area. Narrow benchrock road going down Devils Backbone is not recommended for passenger cars.*

163. DEVILS BACKBONE (CALLAWAY COUNTY)

Callaway County, 3 miles southeast of Fulton, on west side of Stinson Creek, downstream from junction of Youngs Creek and Big Hollow, in W½ sec. 34, T. 47 N., R. 9 W., Fulton 7½-minute Quadrangle.

Because of its serpentine drainage pattern with numerous necks and narrow ridges between loops, Stinson Creek has several sites within two square miles which could appropriately be called Devils Backbone or The Narrows. Mr. E.G. Reynolds of the U.S. Geological Survey kindly relayed field information identifying the true Devils Backbone.

This narrow curved ridge rises 200 feet above Stinson Creek and part of its extent may be driven along via a north-south road.

164. DEVILS BACKBONE (PULASKI COUNTY)

Pulaski County, where west boundary of Fort Leonard Wood cuts across neck of Roubidoux Creek, 5 miles due west of Bloodland, in N½ of south square mile sec. 3 (long section), T. 34 N., R. 12 W., Bloodland 7½-minute Quadrangle.

This site is not named on the Bloodland Quadrangle but was identified on the pre-Fort Leonard Wood map of Pulaski County (Butler, *circa* 1934). It is a narrow neck formed by a tight loop of Roubidoux Creek. The ridge rises 300 feet above the creek and the Bloodland Quadrangle shows a trail along its crest.

The quadrangle also depicts a common characteristic of the Roubidoux; on the south side of the Backbone a permanent eddy is indicated whereas on the north side, no water is indicated in the channel along a lengthy stretch of the stream. Obviously the flow is subsurface in this stretch, in sands and gravels of the streambed and possibly, to some degree, in karst channels.

165. THE PINNACLES

Boone County, 12 miles north of Columbia and 0.5 mile east of U.S. Highway 63, on Silver Fork and Kelley Branch, in NE¼ SE¼ sec. 12, T. 50 N., R. 13 W., Sturgeon 7½-minute Quadrangle (see fig. 72).

Those driving north from Columbia on U.S. Highway 63 may reach a point about 12 miles north of town where they must fight the car's tendency to yaw sharply to the right. This struggle between machine and mind is not

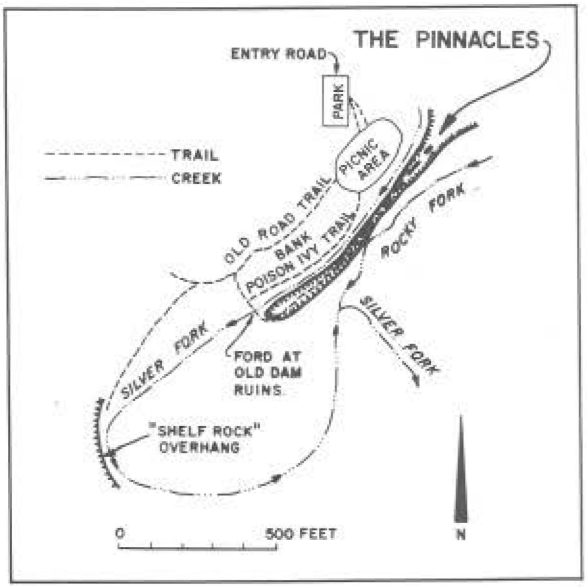


Figure 72

Pace and compass map, The Pinnacles (Boone County), circa 1972.

caused by capricious crosswinds, but rather by the mesmerism of The Pinnacles — kindly Sirens* who lure one from the highway to a compact outpost of Ozarkia. The Pinnacles (fig. 73) are paradoxes, not only in being kindly Sirens, but also by imparting a sense of the primeval despite a heavy traffic of visitors and a nearby highway.

The Boone County Sirens emulate their namesakes by being at the water's edge, in this case between two parallel streams, Silver Fork and Rocky Fork. They were formed as Silver Fork doubled back on itself and these two streams crowded one another so closely that they left a precariously thin 75-foot high and 1,000-foot long limestone ridge as a precipitous erosional remnant.

This senile ridge has very few thousand years of life remaining, for its serrated crest is but several feet wide at points and has already been breached by erosion at two points where large perforations form windows or natural arches.

The Pinnacles have several other namesakes in Missouri: many razorbacked rock cousins named "The Narrows," and numerous similar-appearing kinfolk called "The Devils Backbone." A representative of the latter family also lives in Boone County (No. 162) as well as a Devils Icebox (No. 289), probably a sufficient quota of satanic lairs for one county.

The Pinnacles are composed of the Burlington Limestone, a formation named from outcrops at Burlington, Iowa. In many areas this is an exceptionally pure limestone and is quarried at a number of points in eastern and central Missouri and as far southwest as Springfield, Missouri. This limestone is famous for its fossil remains of crinoids, invertebrate sea animals which superficially resemble plants and thus are colloquially called "sea lilies." The fossil remains are predominantly in the form of calcium carbonate discs or "Indian beads" which may be connected so that they are sometimes incorrectly identified as fossil fish or snake backbones. The Burlington Limestone is the source material for the columns of the University of Missouri-Columbia's Red Campus and Boone County's Old Courthouse.

Those wishing to climb The Pinnacles by the easiest route should ford Silver Fork at the ruins of an old dam, downstream from the picnic area. This ford may be reached via the road which goes southwest from the parking area or by the shorter trail along the northwest bank of Silver Fork.

After fording the stream, climb the trail to the northeast along the east flank of the rock backbone and climb to the crest of the ridge. Where the path reaches the crest the rock is pink, the result of fires oxidizing the trace amounts of iron in the limestone. The rock also contains stylolites, zig-zag structures of debated origin which resemble skull sutures. Cedars (junipers) love bare limestone and this preference is obvious as one looks northeast along The Pinnacles.

At least two geologic phenomena are exemplified at The Pinnacles. One is the probable influence of parallel vertical rock fracture planes as an important factor in determining the parallel stream pattern which produced the narrow ridge. The other phenomenon is the tendency for streams to erode and undercut on the outside of bends because of centrifugal force. The Shelving Rock, opposite the south end of The Pinnacles results from the Burlington Limestone being undercut by erosion so that a shelter 40 feet deep, 125 feet long, and a maximum of 10 feet high has been cut.

On the first bend upstream from The Pinnacles (Silver Fork side), there is a small, single pinnacle, resembling a finger pointing skyward.

The Pinnacles cater to a variety of interests. They have long been popular with young romantics, the camera enthusiast has an excellent excuse to use the wide-angle lens, and kiddies find the climb exciting to self and parent. Because The Pinnacles trend northeast and the steeper northwest side is the most photogenic, lighting is best in late afternoon. Silhouette

---

**The mythologist might well argue that benevolent Sirens are not necessarily paradoxical. The Sirens were originally kindly and fell into the evil ways of luring unwary mariners to their deaths only after losing the District Music Contest (and their feathers) to the muses; a contest which suggests combining the fine arts with cutthroat poker.*

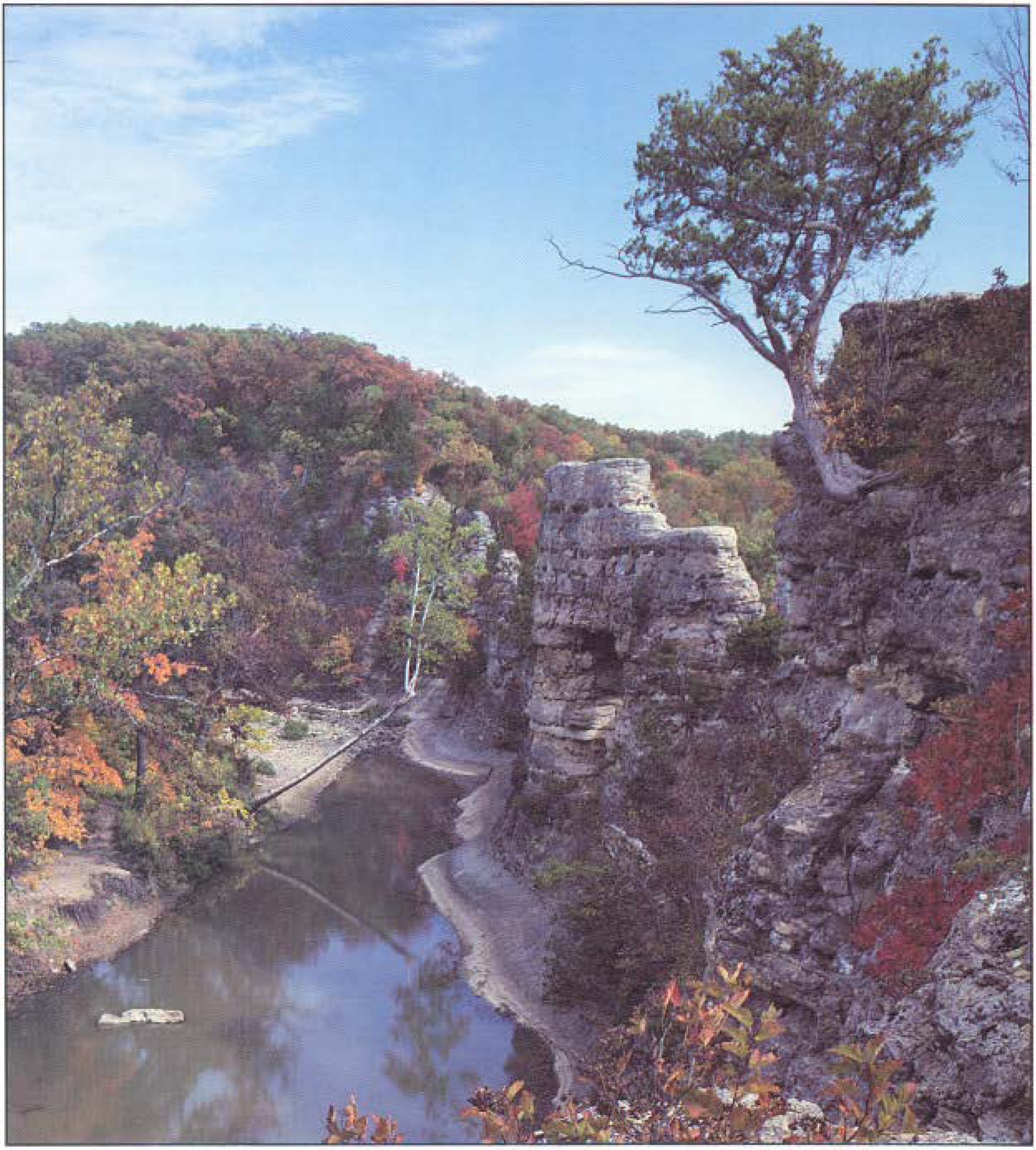


Figure 73

The Pinnacles, north of Columbia, has windows and natural arches formed by erosion. Photo by Gary Reese.

shots in the early morning dramatize the natural arches as sunlight pours through them. The Pinnacles are owned by the Boone County Pinnacles Youth Foundation. The Foundation maintains the park, which is open to the public; they ask only that visitors observe their motto: *"Take nothing but memories, and leave nothing but footprints"* (Thom, 1984). The Pinnacles have also been designated a State Natural Area.

The Pinnacles may be easily reached from the north edge of Columbia as follows:

Miles

0.0 *Head north on U.S. Highway 63 at junction with I-70.*

10.8 *Junction with Missouri Highway 124 eastbound; stay on Highway 63.*

11.7 *Junction with Missouri Highway 124 westbound; stay on Highway 63.*

12.2 *Turn right off Missouri Highway 63 at green "Silver Meadows Girl Scout Camp" sign onto gravel road and double back to the south.*

12.3 *Follow gravel road as it turns left (east).*

12.8 *T-Junction; bridge to left; continue straight ahead to "Pinnacles Youth Park" sign and bear right into parking area.*

166. RICH FOUNTAIN ABANDONED MEANDER LOOP

Osage County, at town of Rich Fountain, on west side of Gasconade River, between Highways 63 and 89, common north corners of T. 42 N., R. 8 and 9 W., Linn and Linn NW 7½-minute Quadrangles (see fig. 74).

The Rich Fountain abandoned meander loop and the accompanying lost hill are by far the most impressive examples of such erosional phenomena in the state. As little as a few tens of thousands of years ago — a relatively short time to the geologist — the Gasconade flowed west at the site of the present Highway 89 bridge, reached the edge of today's Rich Fountain, and then swung north and east to complete the loop at a point slightly downstream from today's bridge. Very close to where the bridge now stands there was a very narrow neck identical to present-day "Narrows" at other locales.

Eventually the neck was breached either through a natural tunnel similar to that at Tunnel Dam (No. 307) southwest of Camdenton or by surface erosion which removed this ridge and allowed the river to take a dramatic shortcut. Regardless of the mode of shortening, because the neck was composed of dolomite, the cutoff was much more difficult to make than those made by the Mississippi within its floodplain where it was "easy going" in eroding clays, silts, and sands. The cutoff left a loop over 8.5 miles long and nearly 0.25 mile wide with a lost hill in the middle surrounded by fertile bottomlands in the abandoned valley.

This loop is best photographed from the air but also may be viewed and photographed from the ground. Highway E follows its south segment as from the Highway 89 junction westward to Rich Fountain. An ideal vantage point for viewing and photographing it is at the overlook east of the Catholic Church.

Unfortunately there is no date for the cutoff, but Carbon-14 dating and archaeological research might well be used to give some approximation. The present abandoned valley is sufficiently high above the active valley of the Gasconade so that it is not commonly subject to flooding, but it does carry drainage from tributary streams.

A visit to the Bavarian community of Rich Fountain should include recognition of the fine architecture and interior work of the Catholic Church, Sanctissimo Cordi Jesu, a name which obviously needs no translation to those familiar with the Latin dative. This church was built in 1879 using the Quarry Ledge of the Jefferson City Dolomite (see No. 150 for notes on the Quarry Ledge). Other buildings in the town have used this rock for foundation work, and construction in the Rich Fountain area exemplifies the fine craftsmanship of the Deutscher stonemason. Rich Fountain was founded in the 1830's, taking advantage of the local springs. A water mill was built in 1839 and was succeeded by a steam mill in 1856. Father Helias founded this parish in 1838 and named the town. Vineyard and Feder (1974, p. 118) give the flow of Rich Fountain Spring in the SW¼ SW¼ sec. 12, T. 42 N., R. 9 W., as 26,000 gallons per day.

Two natural tunnels (Nos. 306 and 315) are crossed by gravel roads within 4 miles of the loop and merit inclusion in the visitor's itinerary as well as Theta Rock (No. 246).

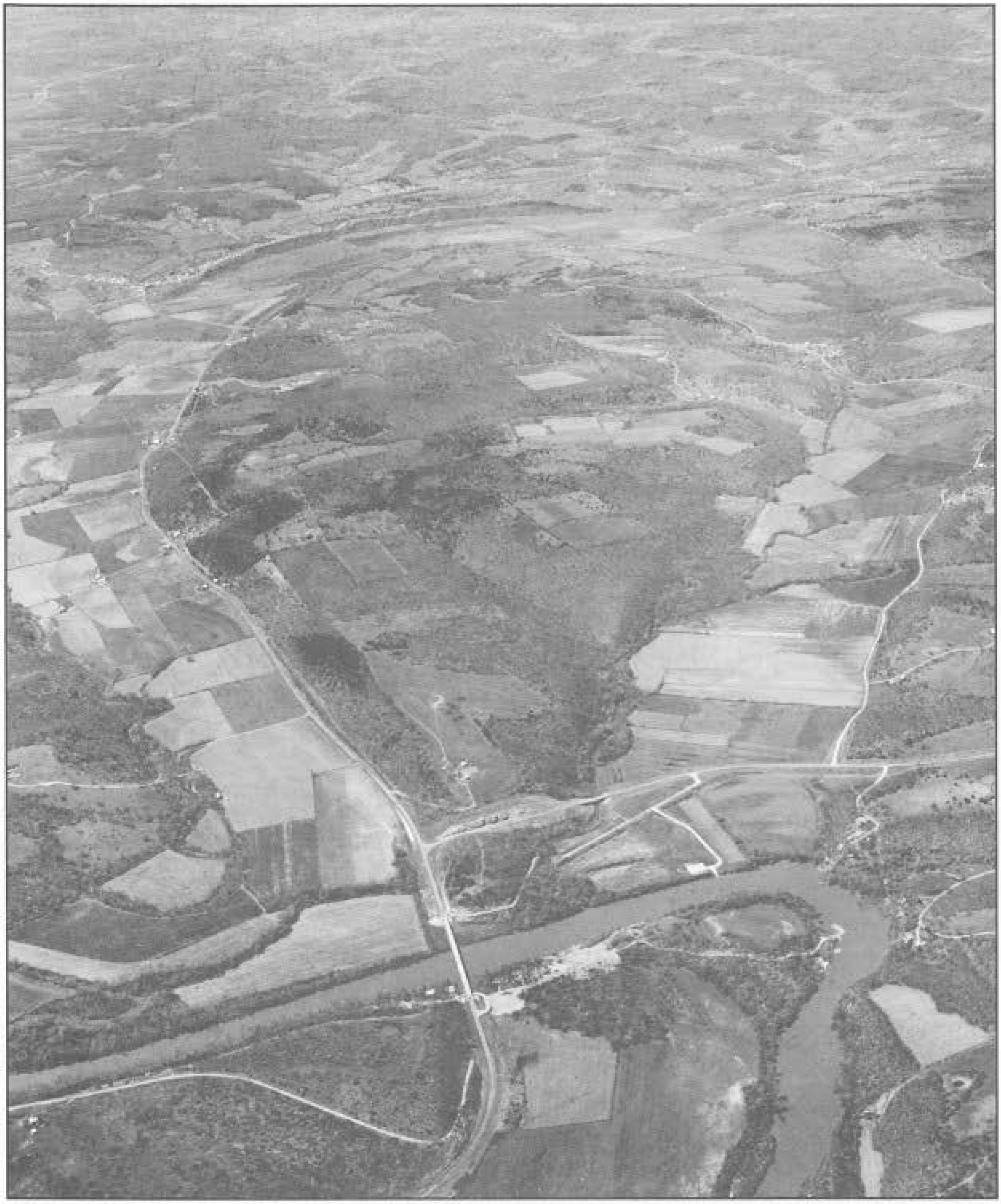


Figure 74

Cutoff meander of the Gasconade River at Rich Fountain, Missouri. Note bank-full stage of the Gasconade, and bedrock exposed in the roadcut through the Narrows of the cutoff. Photo by Jerry D. Vineyard and James H. Williams.

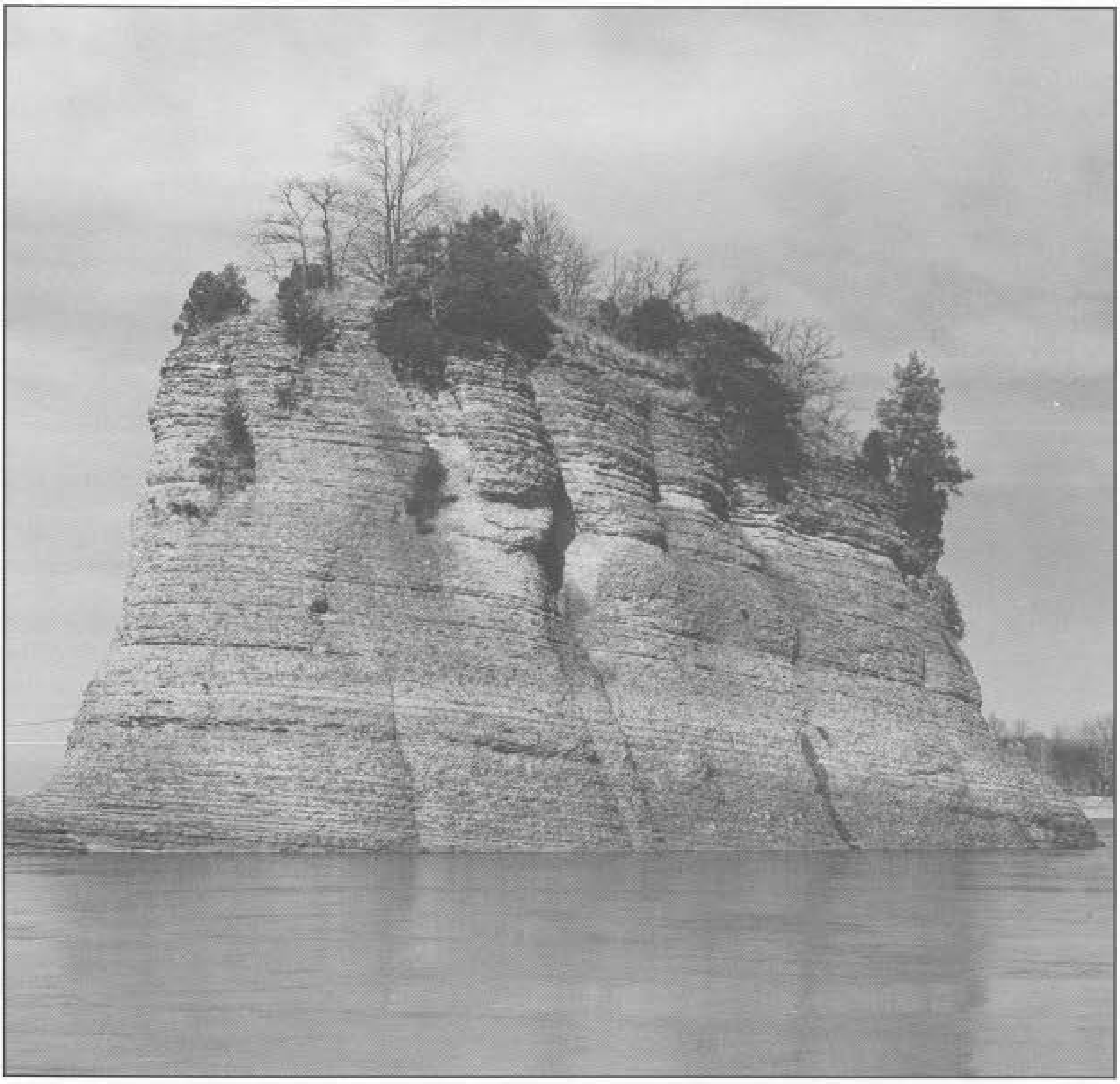


Figure 75

Tower Rock, an erosional remnant from shifts of the Mississippi River channel, is composed of limestone of the Bailey Formation. Photo by Jerry D. Vineyard.

167. TOWER ROCK

Perry County, 1.5 miles south of Wittenberg, in the Mississippi River, near center SE¼ SW¼ sec. 20, T. 34 N., R. 14 E., Altenburg 7½-minute Quadrangle.

Tower Rock (fig. 75) has been known by a number of names including Grand Tower, Castle Rock, La Roche de la Croix (The Rock of the Cross), Devils Tower, and The Rock of St. Cosme, according to Thilenius and Snider (1968, p. 3). Their publication gives a thorough history of this lore-laden site.

This rock is an amphibious version of the lost hill — an erosional remnant left as a result of Mississippi River channel shifts. The Tower, composed of limestone of the Bailey Formation, is about 100 yards in maximum dimension at its base and is slightly under 60 feet high, according to the contour lines on the topographic map. This height is at variance with those given in other references which use figures of 70 to 700 feet. Between the Missouri shore and the rock is The Narrows and below it are a very treacherous eddy and whirlpool reminiscent of a fresh water maelstrom. During low water, one can walk or wade from the Missouri shore across The Narrows to Tower Rock. The whirlpool, as intriguing as the Tower, and the evil navigational reputation of the area are not concealed by subtle currents.

Thilenius and Snider tell of a wedding ceremony on top of the Tower in 1839 following which the bride, groom, bride's parents and sister, the groom's mother, the minister, and three slaves started back to the town of Grand Tower on the Illinois side. Their boat sank into the whirlpool and all perished except one of the slaves who reappeared near the center of the river to be rescued by passing fishermen.

The same writers described the planting of The Cross atop the island by Roman Catholic clergy from Quebec in 1699, thus giving it the name La Roche de la Croix. Another name is derived from that of the chronicler of this expedition, Jean Francois Bouisson de St. Cosme. The contrasts of good and evil in the Tower Rock vicinity are further marked by the lairs of the Devil north of the town of Grand Tower on the Illinois side where a narrow ridge next to the main channel is incorporated in Devils Backbone Park which includes the Devils Bake Oven. A pre-Civil War lithograph of Tower Rock (fig. 76) has the caption "The Devil's Tower" (Anonymous, 1858, p. 434).

Tower Rock has been honored by designation in the National Register of Historic Places.

Ample time should be alloted to enjoy the ride through winding hills and sinkhole topography between Highway 61 and Tower Rock. A most enjoyable route is along Highway A going east from its junction with Highway 61 at Uniontown through the Saxony Hills and the immaculately maintained towns of Frohna and Altenburg, terminating at Wittenberg. Saxony Lutherans landed at Wittenberg in 1839 and established the first home of Concordia Seminary at Dresden in 1839. The log Seminary building of that date was moved into Altenburg and a shelter erected over it in 1912. It is on the south side of Highway A in the heart of the town.

Although the turnoff to Tower Rock is at the west edge of Wittenberg, a side trip to that town is worthwhile. Its population in the 1870's was 500 and it has shrunk considerably. A number of old buildings remain, including the stone-lined rooms where a brewery stored beer in the middle-1800's.

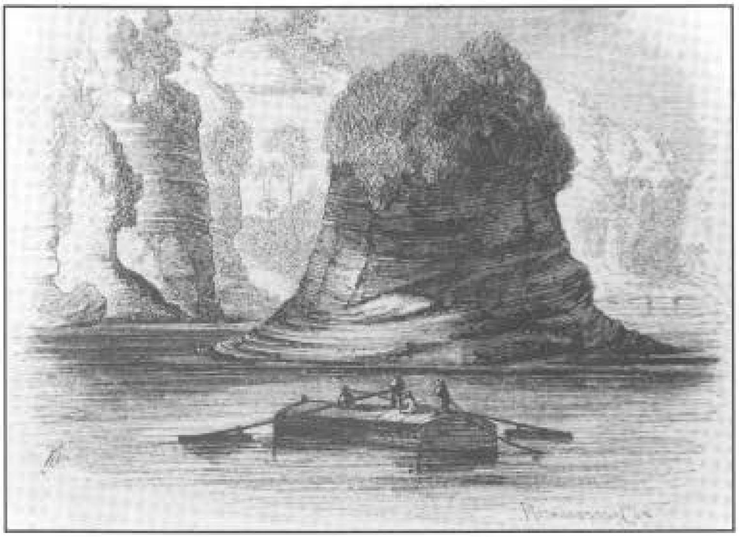


Figure 76

Lithograph of Tower Rock. From Harpers, 1858.

This building is now designated as a bomb shelter.

The turnoff to Tower Rock is at the west edge of Wittenberg where a large arrow and sign "To Ferry" mark the road to follow southward from Highway A. Nearly a mile from the turnoff is another turnoff to the left to the ferry; continue straight ahead on the gravel road past spectacular pipeline crossing towers and an attractive picnic area and campground, thence onward for 1.5 miles from the first turnoff to where the road crosses the railroad track. After crossing the railroad track continue southward for 2.1 miles from where the road recrosses the track. Before crossing the track, park and walk down the gentle bluff to observe Tower Rock and similar neighboring pinnacles on lowlands to the south of the Rock, one of which has been nearly destroyed by quarrying. The best photography will be toward the east and any time from late morning on would be appropriate for lighting. Should time permit, a ferry trip across the river to Devils Backbone State Park and a visit to the historic town of Grand Tower are in order. The Thilenius and Snider publication is almost mandatory for this visit.

During the drought of 1988, the channel between the shoreline and Tower Rock was dry, allowing visitors to walk to and explore the Rock.

168. COTE SANS DESSEIN

Callaway County, on north bank of Missouri River, 11 miles east of Jefferson City, in sec. 18, T. 45 N., R. 9 W., and part of sec. 13 to the west, Osage City and Loose Creek 7½-minute Quadrangles.

Cote Sans Dessein (Hill Without Design) is locally known as Cote Hill (a redundant name because Cote means hill), or if used in its entirety is pronounced with the Sans Dessein portion rhyming with Anderson minus the "r." The Cote is without doubt the most historic lost hill in Missouri and has been the subject of an excellent book (Bell, 1930) summarizing its days of glory and defeat.

The hill is a mile-long ridge, 200 yards wide at the base and approximately 150 feet high, composed of Jefferson City Dolomite, isolated in the Missouri River valley and hugging the left or north bank of the stream (fig. 77). The chain of events which resulted in its being left as an erosional remnant cannot be recited. All we can say is that the Missouri River, perhaps abetted by its tributaries, somehow failed to complete its erosional duties during wanderings which produced the present broad floodplain and left this isolated rock remnant. Obviously, the Missouri River has been at some time or other on the north side of the ridge, and were she not controlled in part by man-built structures she might well return to her former haunts.

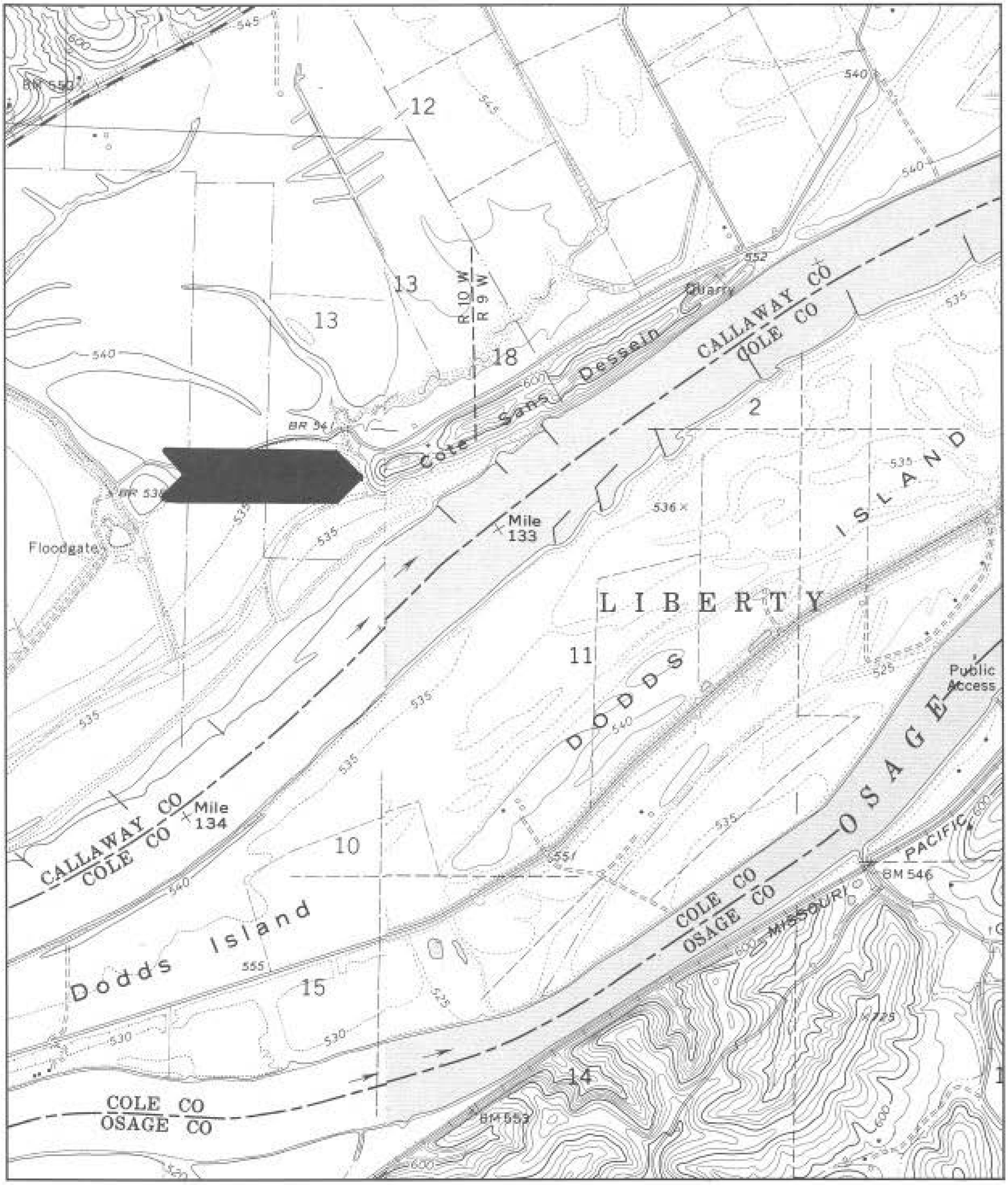
Nearly all the historical data cited herein are from Bell's publication. The French Canadian settlement of Cote Sans Dessein was established in 1808 and, according to Bell (p. 9),

"...had the distinction for two years of being farthest West in the United States, for until Americans settled in the Boone's Lick country in 1810, there was no other settlement west of Loutre Island."

Jean Baptiste Roy (or Roi) established the settlement with a grant deeded to him by Pierre Chouteau, the famous St. Louis trader and entrepreneur. The village was on the flatland next to the river rather than on the ridge, and by 1815 the population was approximately 200.

On April 4, 1815 the settlement was attacked by Indians (who were allies of the British in the War of 1812), resulting in the death of five Frenchmen and about 14 Indians. This event was noteworthy for its date because it occurred after the war officially ended on December 24, 1814. The settlers were aware of the enemy strategy of having Indians attack outposts in Missouri and, according to Bell (p. 37),

"...erected 2 forts and 2 blockhouses for their protection. The larger of the forts, known as Thibault's, was situated near the east end of the hill and 30 or 40 yards from the river. Within its palisades was a blockhouse and also several cabins in which settlers dwelt. The smaller fort was Roi's and possibly


Cote Sans Dessein
Quarry
CALLAWAY CO
COLE CO
Mile 133
Mile 134
LIBERTY
ISLAND
DODDS
Dodds Island
OSAGE
COLE CO
OSAGE CO
Floodgate
Public Access
MISSOURI PACIFIC
R 10 W
R 9 W
BM 550
BR 541
BR 536
BM 546
BM 553
12
13
13
18
2
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15
14
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600
725

Figure 77

Cote Sans Dessein (Hill Without Design) is the most historic lost hill in Missouri. It is a 150-foot high, mile-long ridge that is isolated in the Missouri River a few miles east of Jefferson City. The flood of 1986 covered the entire floodplain of the Missouri River, leaving Cote Sans Dessein as an island in the flood. Topography from Osage City and Loose Creek 7½-minute Quadrangles, U.S. Geological Survey.

was as much as four hundred yards farther down the river. Near it was a blockhouse, also Roi's, and to the rear of this was Roi's barn. Between the forts and even closer to the river was a log building that was used for a powder magazine."

Switzler (1879, p. 175-176) cites a historic event in the battle which shows the character of Roy (Roi):

"During this siege the women moulded bullets and cut patches for the men who were kept busy in firing upon the assailants. The consequence was that a good many of them were killed, which so exasperated the remainder that they determined to take by storm or to destroy by fire the block-house. The storming process failing, they fastened combustible matter to their arrows, and, lighting it, shot their missiles in to the roof; as often as this was done the women extinguished the blaze by the careful use of portions of the small supply of water in the building. It was with appalling interest the heroic band observed this supply rapidly lessening as the savage incendiaries repeated their efforts to fire the roof. But the women determined to hold the fort and continued to apply the water. Finally, however, the supply was exhausted, the last drop was gone, and the block-house blazed above their heads. One of the women produced a pan of milk and extinguished the flames. Very soon another arrow of fire set the roof ablaze and a demoniac yell arose from the savage foe. Even Roi himself looked aghast and trembled with fear, for he knew of no other means of averting the perils of the awful crisis. But hold the fort was the maxim of the women, and just in the nick of time Madame Roi produced from the urinal a fluid that again extinguished the flames, and saved the garrison. When, long after the war, this achievement was talked over in St. Louis, some young men united in the expense of procuring a rifle of fine finish as a present to Monsieur Louis Baptiste Roi in testimony of his gallant defense of Cote Sans Dessein. Some of them also suggested playfully that a silver urinal ought to be presented to Madame Roi for the distinguishing part she bore in the perilous defense of the block-house. Unfortunately, as it afterwards proved, this suggestion came to the ears of Monsieur Roi. When, therefore, the committee waited on him with the rifle and asked him to accept it, he is reported to have replied as follows: 'Gentlemen: It is a fuzee of beautiful proportions — containing very much gold in de pan, and silver on his breeches; he is a very gentleman gun for kill de game. I tank you. I shall not take him. Some gentlemen have consider to give ma chere amie one urinal silvare! I tell you, sare, I take care of dem tings myself — go to h--ll avec votre dam long gun! I shall not take him!! Go to h--ll, anybody by d--n sight!!!' And with this expression of resentment for the freedom that the young men had unwittingly taken in the discussion of the affair he departed with manly indignation, in perfect keeping with his admirable character."

When Missouri became a state, the General Assembly was faced with a problem of locating the capitol and chose a commission of five men to select a site on the Missouri River within 40 miles of the mouth of the Osage, with instructions to meet at Cote Sans Dessein to make the decision. The Cote area filled the specifications geographically and one of the reasons it did not become the capitol was the overly conspicuous pro-capitol lobbying activities of land speculators. In 1844 a flood destroyed the village and its memory is perpetuated only by the hill, the name of the township, and the scribes of history. Some quarrying activity at the hill alerts us to the danger of complete obliteration of the site.

The hill may be reached by the following routes:

Miles	
0.0	*Junction of Highways 54 and 94 northeast of Jefferson City. Drive east on Highway 94.*
5.7	*Wainwright Junction. Continue east on 94.*
8.3	*Turn right off 94 onto gravel road and follow to west end of Cote Sans Dessein which is 1.6 miles off the highway. The gravel road follows the north side of the Cote for an additional mile to a T-junction described in the route below.*

Optional route to the Cote:

Miles

0.0 Junctions of Highways BB and 94 between Wainwright and Tebbetts. Several yards east of this junction turn right (southeast) — off 94 and follow narrow gravel road for 1.1 miles southeast to a T-junction at east end of Cote. This is the same junction as described in route above. If one turns left he will be in front of the Pinet House on the left 0.1 mile from this junction.

A few years ago a quarry operation started at the east end of the Cote and continued for approximately 200 yards down the center of the ridge, gutting it but exposing an excellent section of the loess cap approximately 20 feet thick. Near the east end of the ridge along the road paralleling the north side, erosion has exposed more loess, suggesting the possibility that the ridge was left as an erosional remnant and then covered with loess. If this be the case, the student of Pleistocene (Ice Age) loess deposits might be able to date the ridge as having developed prior to or during one of the glaciations.

The Pinet House has been described by Williamson (1970) and Clark (1971) as having been built in the early 1880's. According to Clark this house stands: *"...across a dirt road from the approximate site of the large blockhouse and cabin used to store powder at Cote Sans Dessein."* Clark also states, *"Today, the site of the bigger blockhouse has been cut away by construction crews for sand and gravel."* He describes the smaller blockhouse as having been located *"...about 300 yards down river..."*

169. HOOD HILL

Osage County, a half mile west of Cooper Hill, in S½ sec. 35, T. 43 N., R. 7 W., Cooper Hill 7½-minute Quadrangle, on which it is named.

Hood Hill is a beautiful, isolated triangular hill with a narrows and an almost-cut-off meander. Mistaken Creek and Third Creek are the geomorphic "artists." Highway D crosses the narrows, and homes occupy the lost hill.

170. LOST HILL

Barry County, in Table Rock Lake, 2 miles northwest of Viola, in SW¼ sec. 23, T. 22 N., R. 25 W., named on Viola 7½-minute Quadrangle.

This feature started modern life as a lost hill resulting from a cutoff in a deeply entrenched loop of White River. Impounding had made it into an island rising about 80 feet above lake level as contrasted with its pre-insular height of some 130 feet above the valley floor.

OTHER LOST HILLS

Some lost hills are so designated by distinctive name ("lost hill") on topographic maps; those not named on topographic maps are indicated by an asterisk (*) on Feature Nos. 171-185.

171. *LOST HILL	Two miles east of Union, near 5th Principal Meridian, Franklin County, Moselle 7½-minute Quadrangle.	Cutoffs have produced twin lost hills in the Bourbeuse valley.
172. LOST HILL	Three miles east of St. Clair, a lost hill in secs. 27 and 28, T. 42 N., R. 1 E., is flanked by Cove Creek. This creek flows in the cove formed by the abandoned meander loop, Franklin County, St. Clair 7½-minute Quadrangle.	The term "Cove" is a Southern Appalachian usage carried into the Ozarks.
173. LOST HILL	Former Lost Hill School named from nearby feature, 3 miles south of Pershing on Second Creek, in sec. 28, T. 44 N., R. 6 W., Gasconade County, Pershing 7½-minute Quadrangle.	An incipient lost hill waiting for further erosion to isolate it is 2 miles to the south.
174. *LOST HILL	Greene County, Ebenezer 7½-minute Quadrangle.	See No. 340, Dry Sac Lost Hill Area.
175. LOST HILL	Three miles east of St. Elizabeth, on Tavern Creek, in SE¼ sec. 22, T. 41 N., R. 12 W., Miller County, Meta 7½-minute Quadrangle.	One-half mile in diameter; summit 200 feet above Tavern Creek.
176. *LOST HILL	On north side of Moniteau Creek, 6 miles north of California, in secs. 14 and 23, T. 46 N., R. 15 W., Moniteau County, California North 7½-minute Quadrangle.	This quadrangle contains several other interesting stream phenomena. To the east of the lost hill is a mile long narrows in secs. 14 and 24. To the south in the S½ sec. 23, a northeast-trending bluff is exceptionally straight and sheer, suggesting fracture control. Other valleys in this quadrangle north of California also suggest fracture control by their parallelism and straight bluff lines. Gooseberry Hollow on the south side of Moniteau Creek demonstrates stream piracy. This tributary now enters Moniteau Creek through a narrow gap in a ridge in the center east line. It originally joined Moniteau in the north-central part of sec. 22, 0.5 mile to the northeast.
177. *LOST HILL	Near the center of sec. 9, T. 22 N., R. 12 W., less than a mile north of Tecumseh, Ozark County, Udall 7½-minute Quadrangle.	Pine Hill at the junction of Bryant Creek and North Fork River has been cited in many listings of Ozark scenic sites. This 80-foot lost hill was formed by a meander cutoff on Bryant Creek.

178. *LOST HILL	On Dry Fork, 4 miles southeast of St. James and 4 miles southwest of Maramec Spring. Double lost hills in secs. 16 and 21, T. 37 N., R. 6 W., Phelps County, Maramec Spring 7½-minute Quadrangle.	(Note spelling of Maramec, the official designation for the spring). Figure 78 shows the postulated sequence of cutoffs.
179. LOST HILL	On west side of Big Piney River, 2 miles south of Devils Elbow, near northeast corner of Fort Leonard Wood, NE¼ sec. 25, T. 36 N., R. 11 W., Pulaski County, Devils Elbow 7½-minute Quadrangle.	Cutoff gap and portion of abandoned loop used by Fort Leonard Wood railroad.
180. *LOST HILL	Spillman Mound, center in southwest corner sec. 30, T. 64 N., R. 11 W., Scotland County, 2 miles northeast of Greensburg, Greensburg 7½-minute Quadrangle.	This is a very conspicuous lost hill rising 70 feet above the broad valley of Middle Fabius River on the south side of the stream.
181. *LOST HILL (LONE ROCK)	On east side of Highway 71, 3.8 miles south of its junction with EE and A at Chaffee, in SW¼ SW¼ NE¼ SE¼ sec. 36, T. 29 N., R. 12 E., Scott County, Chaffee 7½-minute Quadrangle.	Designated as Lone Rock on topographic map. Twenty feet tall by 50 to 60 feet in diameter.
182. LOST HILL	Three miles northeast of Chaffee, in NE¼ sec. 4, T. 29 N., R. 13 E., Scott County, Scott City 7½-minute Quadrangle.	This hill (fig. 79) and those north of Bell City are but a few of the many left as remnants as the Southeastern Lowlands were eroded by former rivers (see section on Southeastern Lowlands).
183. *LOST HILL	In S½ sec. 32, T. 57 N., R. 9 W., 1.5 miles northeast of Lakenan, Shelby County, Lakenan 7½-minute Quadrangle.	"The Mound" on the north side of North Fork Salt River and an unnamed mound in sec. 5 on the south side are both excellent examples of lost hills.
184. LOST HILL	Two miles east of Pacific on north side of Meramec River in extreme southwest St. Louis County. Would probably have been in Jefferson County if cutoff had not been made and it had remained on south side of Meramec. Pacific 7½-minute Quadrangle.	More than a mile long; summit 160 feet above the river. Meramec shortened by more than 4 miles as result of this cutoff.
185. LOST HILL	One mile west of Perkins or 5 miles north of Bell City, in NE¼ sec. 14, T. 28 N., R. 11 E., Stoddard County, Bell City 7½-minute Quadrangle.	Similar erosional remnants to east and south (Cow Hill, Bird Hill, and Ringer Hill).

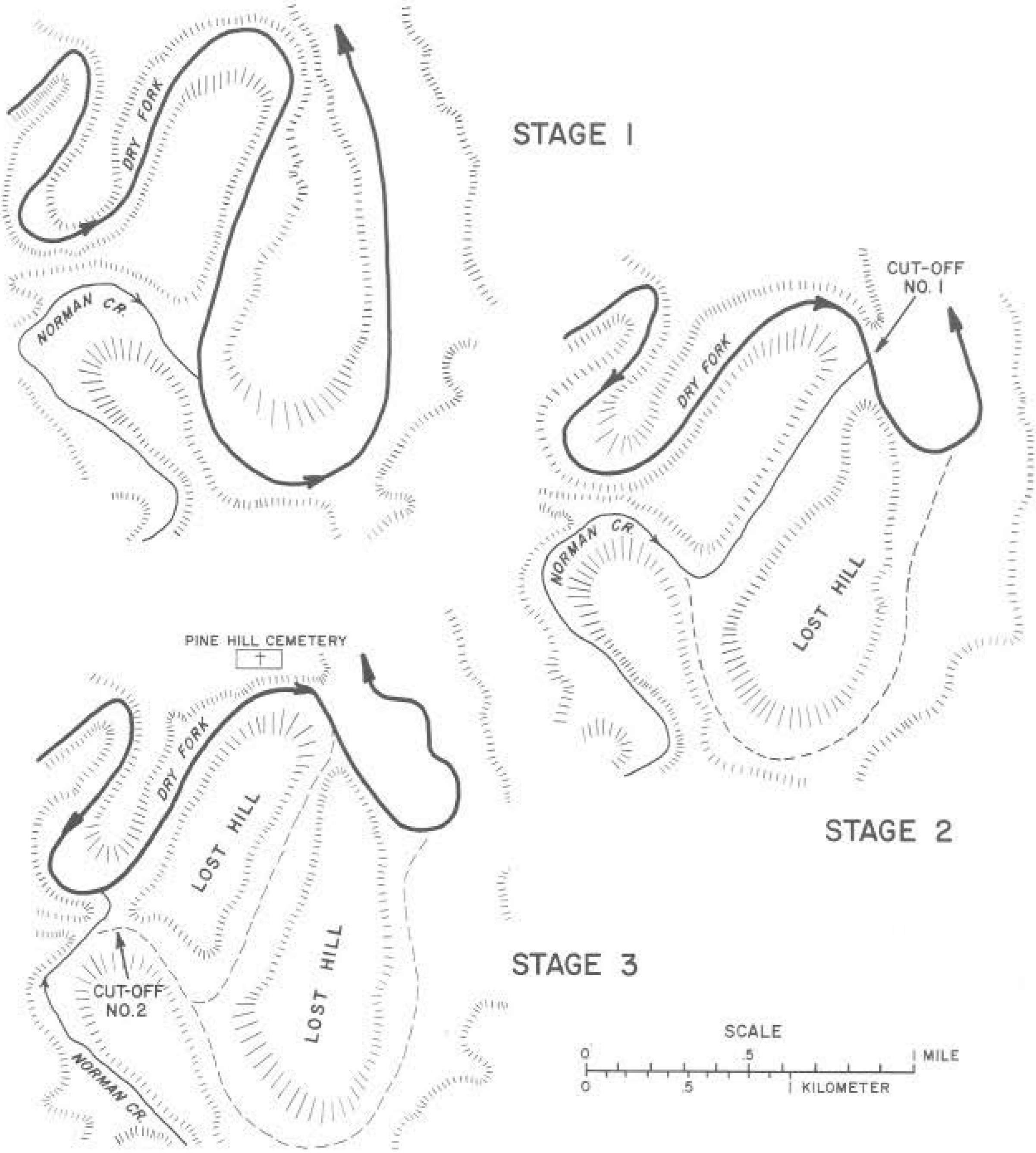

STAGE I
DRY FORK
NORMAN CR.
STAGE 2
CUT-OFF NO. I
DRY FORK
NORMAN CR.
LOST HILL
PINE HILL CEMETERY
DRY FORK
LOST HILL
LOST HILL
CUT-OFF NO.2
NORMAN CR.
STAGE 3
SCALE
0 .5 I MILE
0 .5 I KILOMETER

Figure 78

Postulated sequence of cutoffs that created double lost hills (No. 178) on Dry Fork in Phelps County.

186. LOST HILLS IN THE SOUTHEASTERN LOWLANDS

The New Madrid earthquakes of 1811-12 cannot take credit for the Lowlands of southeastern Missouri. The main factor in shaping this landscape was the complex history of wandering streams planing much of the area to exceptionally low relief but leaving ridges and hills behind as small and large scale "lost hills."

The Mississippi River was undoubtedly one of the major erosional agents and may have at one time had a valley at the northwest edge of the Lowlands adjacent to the present site of Poplar Bluff. Reconstructing the courses of this stream, the Ohio, and other more local streams is not simple and the accompanying sketch map probably will be modified as new geologic data are accumulated and analyzed.

For the purposes of the present discussion the main issue is not one of exactly when what stream flowed where, but rather the fact that the area was the subject of intense erosion by major streams and that the hills and ridges were not pushed up but are survivors of this activity.

Crowleys Ridge is undoubtedly the largest lost hill in Missouri, having a length of at least 35 miles in this state plus more than 100 miles in Arkansas. This ridge is some 300 feet high and nearly 20 miles wide. The Sikeston Ridge is also about 35 miles long but rises a maximum of only 25 feet above the adjacent lowlands.

As is obvious in figure 80, smaller isolated hills vary in diameter from 10 miles down to mere pinnacles. An isolated remnant pinnacle is Lone Rock (No. 181), south of Chaffee. Another isolated hill which has won the dignity of being named Lost Hill is No. 182 (fig. 79), 3 miles northeast of Chaffee or 1 mile northeast of its namesake town, Rockview. Lost Hill and a small satellite hill 0.1 mile to the east are conspicuous from Highway M east of Rockview.

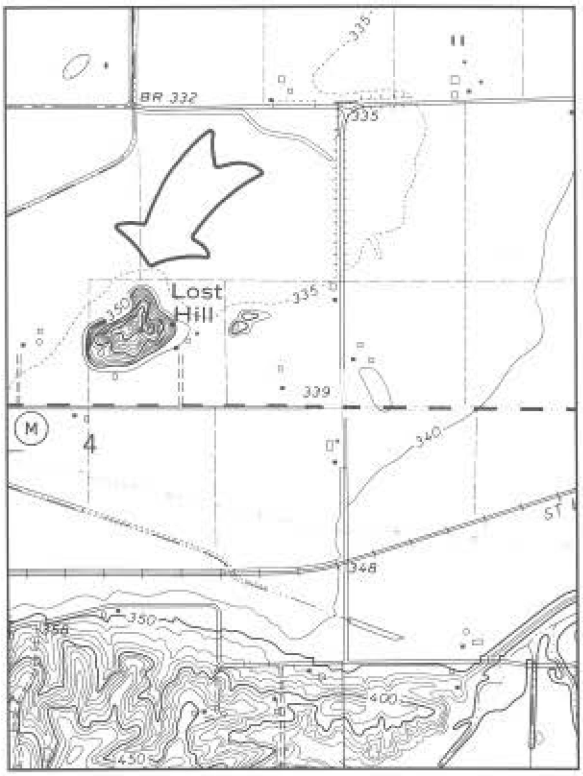
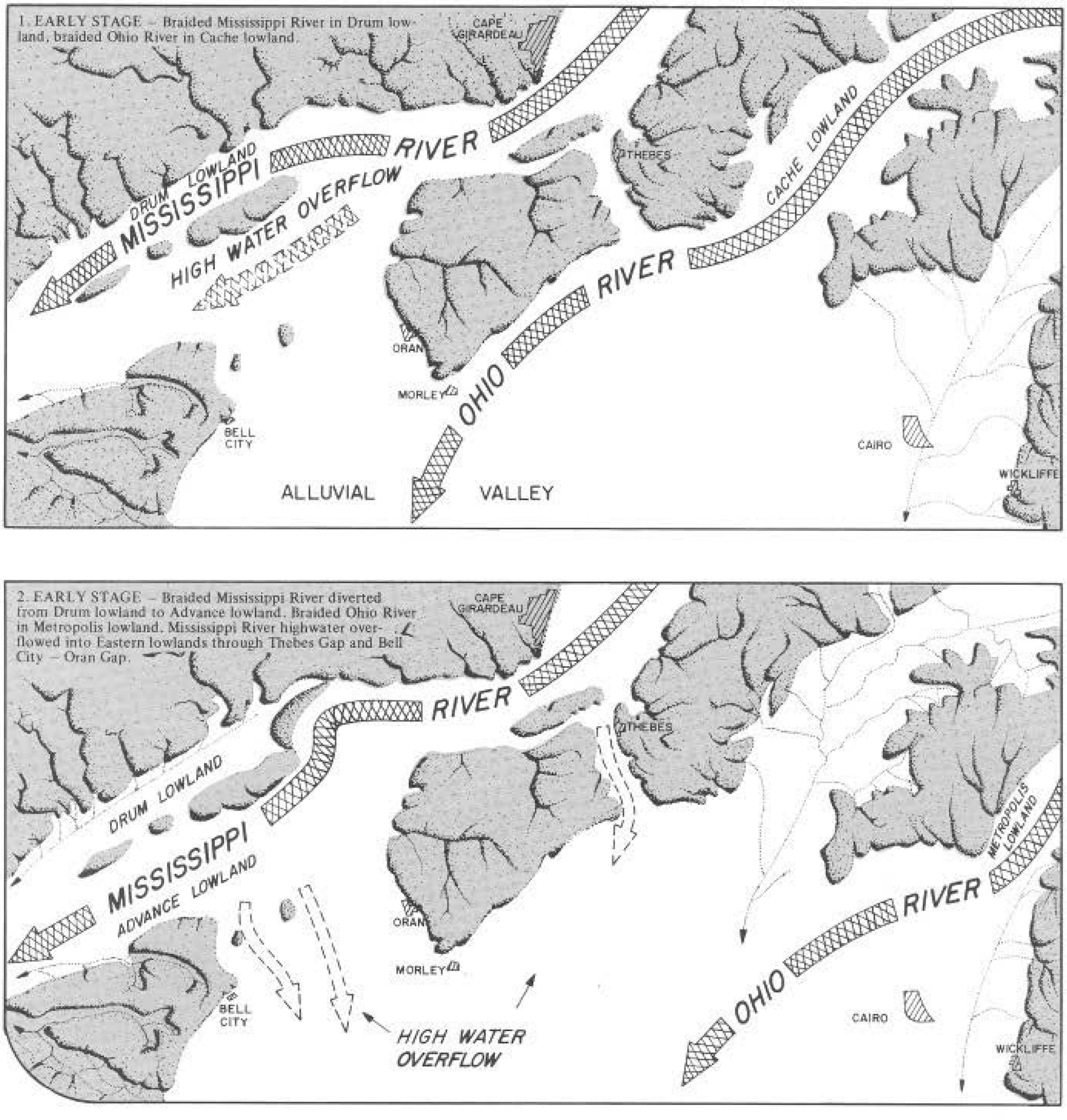


Figure 79

This lost hill, so named on the Scott City 7½-minute Quadrangle, is 3 miles east of Chaffee.

The flatness of the Lowlands is the result of both stream erosion and the deposition of alluvial deposits; the fertility of the soil results from such deposition as well as the fact that the area was quite swampy and conditions were ideal for the development of a thick humic soil. The general slope of rocks in the Lowlands area is away from the Ozarks or toward the southeast, and as a result a variety of rock types is represented in the area including sandstones, dolomites, and limestones as old as Ordovician and clays, sands, and gravels dating from later geologic time to relatively recent.

Although the New Madrid earthquakes did not create the Lowlands, they did cause a bit of topographic shuffling. Parts of the Lowlands were depressed to become swamps and other parts which had been swamps were raised to become dry land. Reelfoot Lake in Tennessee southeast of New Madrid exemplifies this topographic warping. Part of Reelfoot Creek was depressed to create a large submerged area whereas downstream from this, rising of the surface created a natural dam.



1. EARLY STAGE – Braided Mississippi River in Drum lowland, braided Ohio River in Cache lowland.

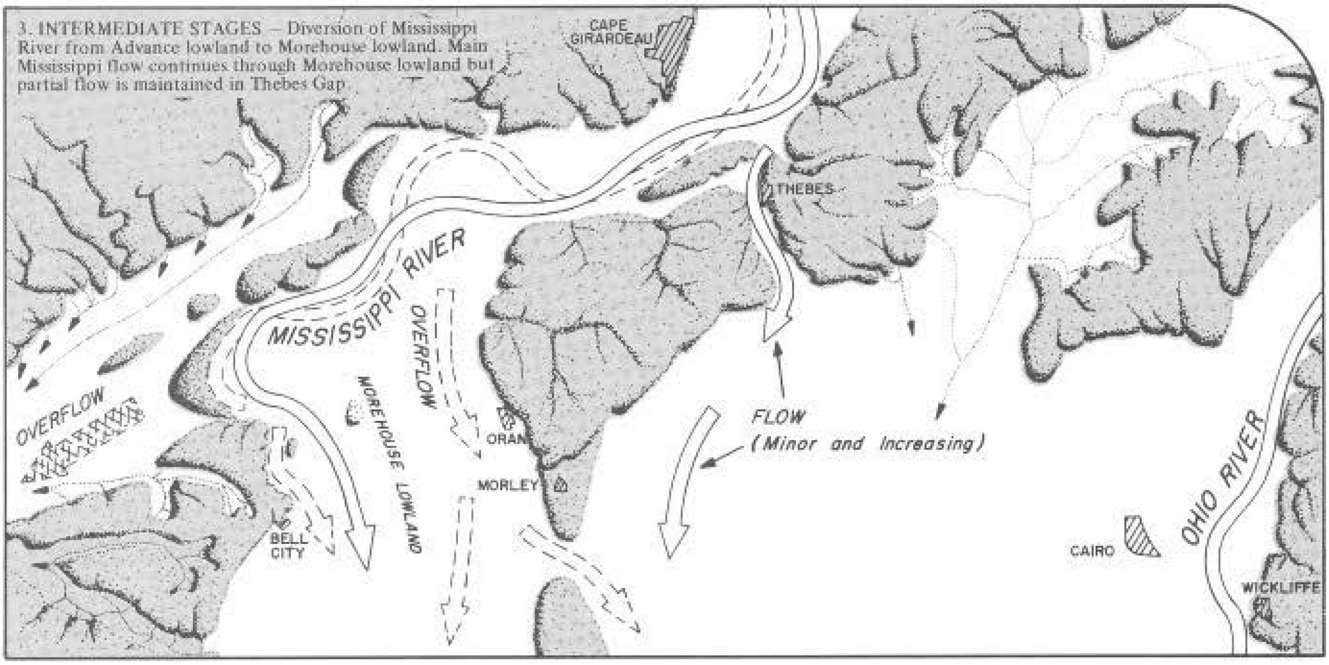
CAPE GIRARDEAU
DRUM LOWLAND
MISSISSIPPI
RIVER
HIGH WATER OVERFLOW
THEBES
CACHE LOWLAND
OHIO
RIVER
ORAN
MORLEY
BELL CITY
CAIRO
WICKLIFFE
ALLUVIAL
VALLEY

2. EARLY STAGE – Braided Mississippi River diverted from Drum lowland to Advance lowland. Braided Ohio River in Metropolis lowland. Mississippi River highwater overflowed into Eastern lowlands through Thebes Gap and Bell City – Oran Gap.

CAPE GIRARDEAU
RIVER
DRUM LOWLAND
MISSISSIPPI
ADVANCE LOWLAND
THEBES
ORAN
MORLEY
BELL CITY
HIGH WATER OVERFLOW
METROPOLIS LOWLAND
OHIO
RIVER
CAIRO
WICKLIFFE

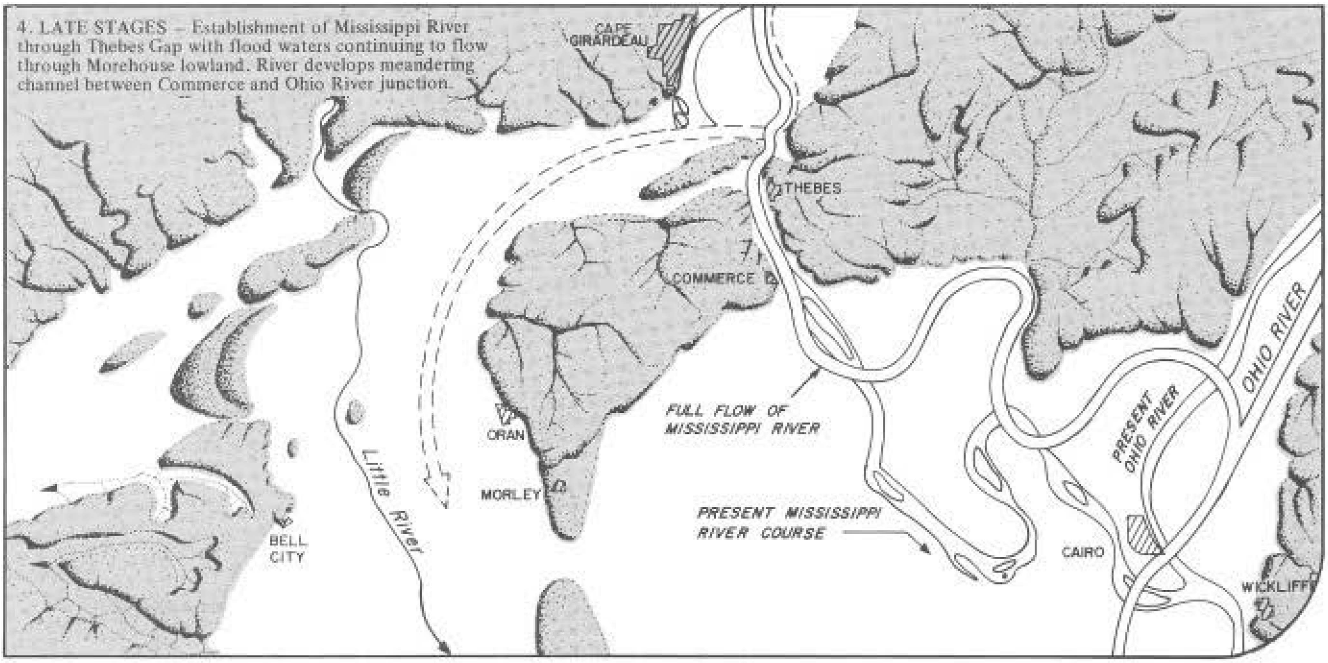
Figure 80

Numerous hills and ridges in the Southeastern Lowlands (No. 186) are survivors of intense erosion by major streams. Stages in development of the Mississippi River channel and lost hills and ridges are shown here. From Thacker and Satterfield (1977). Drawings by Billy G. Ross.



3. INTERMEDIATE STAGES – Diversion of Mississippi River from Advance lowland to Morehouse lowland. Main Mississippi flow continues through Morehouse lowland but partial flow is maintained in Thebes Gap.

CAPE GIRARDEAU
THEBES
MISSISSIPPI RIVER
OVERFLOW
MOREHOUSE LOWLAND
OVERFLOW
ORAN
MORLEY
BELL CITY
FLOW
(Minor and Increasing)
OHIO RIVER
CAIRO
WICKLIFFE



4. LATE STAGES – Establishment of Mississippi River through Thebes Gap with flood waters continuing to flow through Morehouse lowland. River develops meandering channel between Commerce and Ohio River junction.

CAPE GIRARDEAU
THEBES
COMMERCE
ORAN
MORLEY
BELL CITY
Little River
FULL FLOW OF MISSISSIPPI RIVER
PRESENT MISSISSIPPI RIVER COURSE
PRESENT OHIO RIVER
OHIO RIVER
CAIRO
WICKLIFFE

In 1912 the U.S. Geological Survey published Bulletin 394, *The New Madrid Earthquake.* This has long been out-of-print but fortunately it was reprinted with an accompanying modern publication, *Geography and Geology of the Southeast Missouri Lowlands,* listed in the Bibliography under Fuller and Magill.

Geologists would agree that the New Madrid earthquake was caused by sudden movement along a fault or fault zone but no one has seen the New Madrid fault. It can only be calculated as existing from seismic data because the fracture or fracture system is completely concealed by a thick blanket of alluvial material.

Such a terse description of an area with such a complex geological history is necessarily inaccurate. The Fuller and Magill publication should be in the library of anyone interested in the area, especially in light of the fact that the New Madrid earthquakes were landmarks in the seismic history of the United States.

Pinnacles, pedestals,
pediments and palisades;

The harder they spell,
the easier they photograph...

7

Stream Piracy or Capture

Not all streams are ethical — a fact documented by the many cases of stream piracy in Missouri. Stream piracy may be defined as the diversion of the water of a stream by another stream which has intercepted the diverted stream at any point above its mouth. As shown in figure 81, this hydrologic short-circuiting may be consummated by a stream eroding headward until it taps the headwaters of another stream which has a lower gradient.

The pirate or captor, because of its higher gradient, will erode headward, occupying the valley of the beheaded stream with a resulting reversal in the downstream slope and direction of water flow of the captured stream. This erosion will cause the divide between the two watersheds to move toward the mouth of the beheaded stream. Because the beheaded stream has lost much of its water supply to the pirate or captor, its flow may be so slight that it is for practical purposes an abandoned stream valley.

Capture may be by a flanking action as shown in figure 82. This type of piracy involving a major stream capturing its own tributary is the most common type of obvious surface piracy in Missouri.

Subterranean piracy takes place when a surface stream is diverted to the underground via a sinkhole or cave within its valley (fig. 83). In some cases this captured stream remains underground until it finally emerges as a feeder to a major spring as in the Grand Gulf-Mammoth Spring system. In other cases, the stream may be underground for a short time in a natural tunnel environment as exemplified by The Sinks (No. 308) and Jam-Up Cave (No. 311) in Shannon County.

The piracy may be a combination of the above phenomena in cases where two parallel streams are separated by a narrow ridge and the captor utilizes a fissure or cave through the ridge as a vulnerable point for the capture. Clifty Hollow and Tunnel Cave natural bridges (Nos. 278 and 315) exemplify such a history.

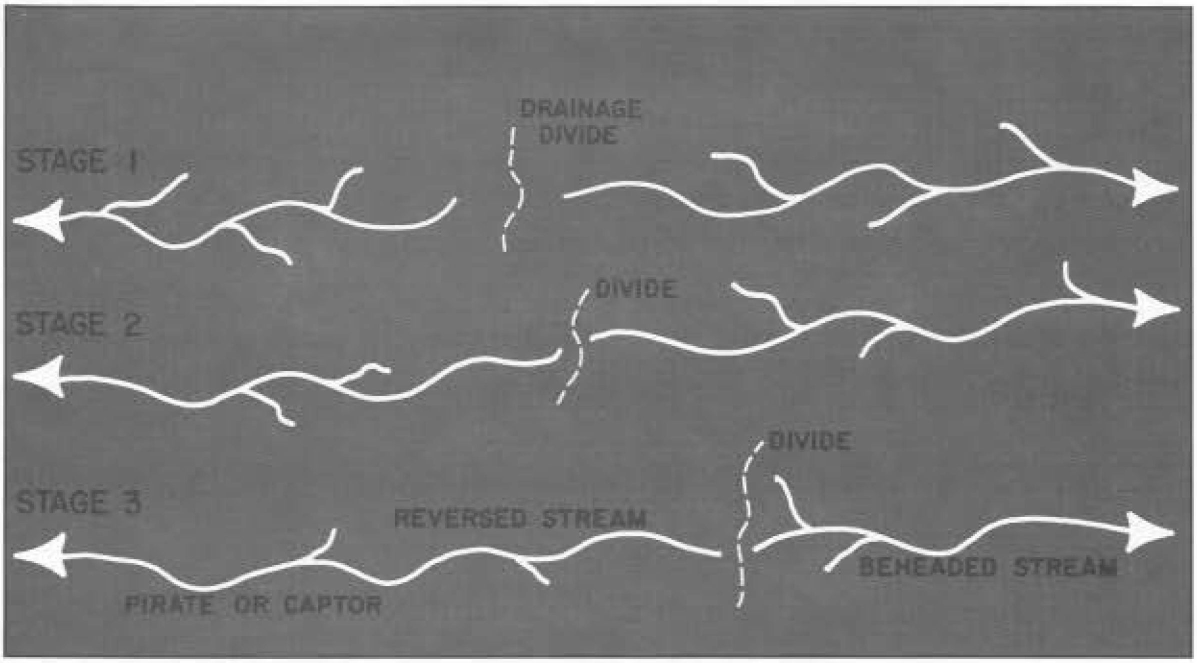

STAGE 1
DRAINAGE DIVIDE
STAGE 2
DIVIDE
DIVIDE
STAGE 3
REVERSED STREAM
BEHEADED STREAM
PIRATE OR CAPTOR

Figure 81

Sequences in stream capture. The stream to the left has greater gradient than the stream to the right and therefore erodes headward more rapidly to become the "pirate" in stage 3.

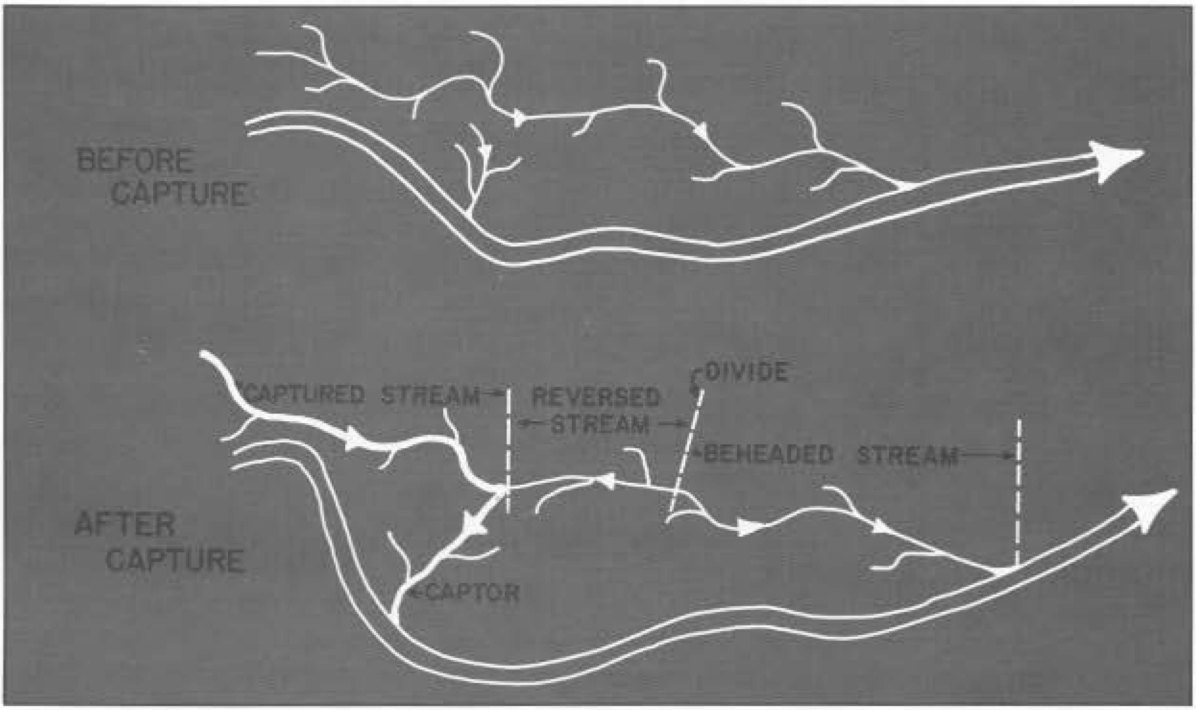

BEFORE CAPTURE
DIVIDE
CAPTURED STREAM
REVERSED STREAM
BEHEADED STREAM
AFTER CAPTURE
CAPTOR

Figure 82

Stream capture by a flanking maneuver. Probable future capture by a major stream is indicated by the "X."

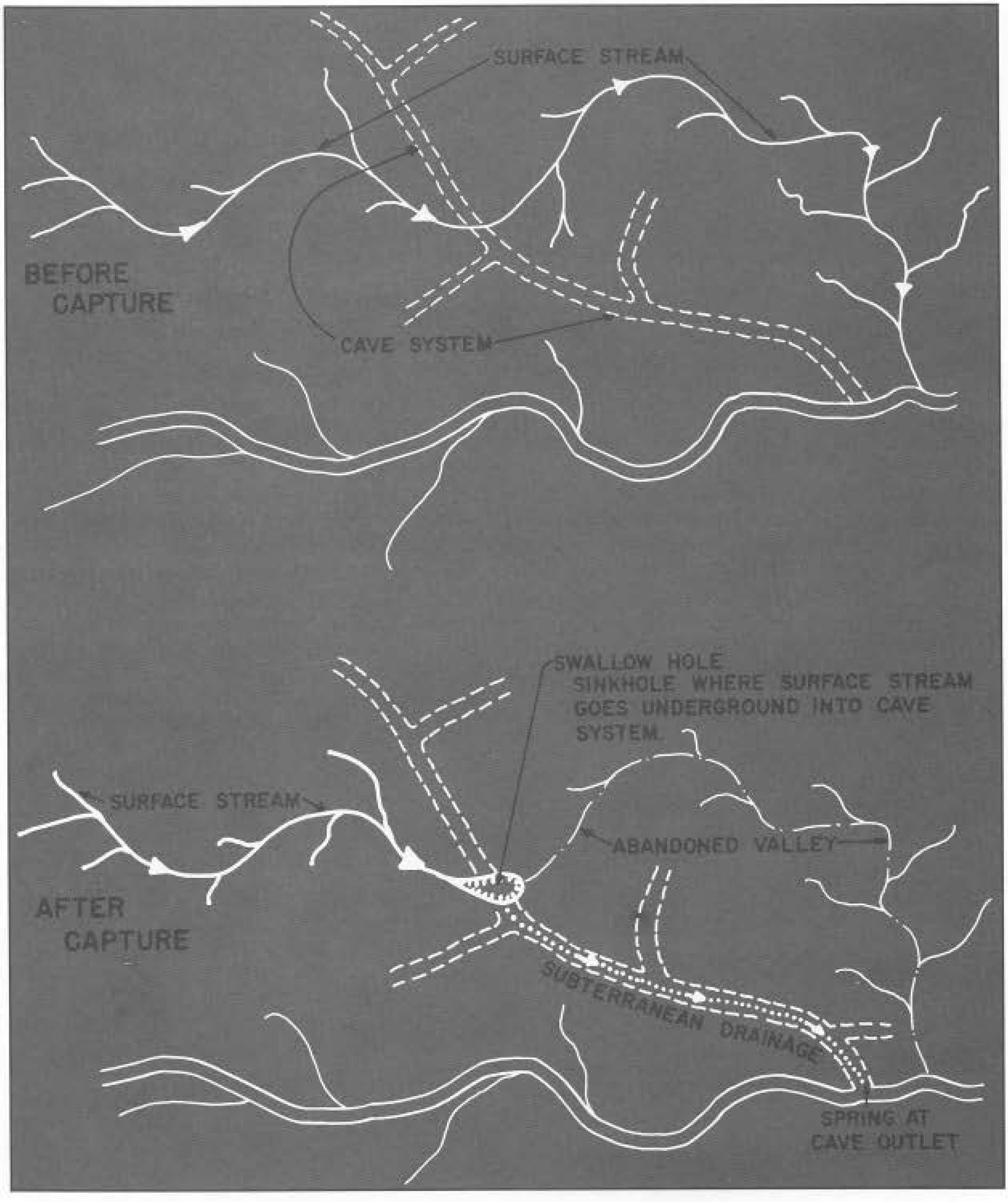

SURFACE STREAM
BEFORE CAPTURE
CAVE SYSTEM
SWALLOW HOLE
SINKHOLE WHERE SURFACE STREAM GOES UNDERGROUND INTO CAVE SYSTEM.
SURFACE STREAM
ABANDONED VALLEY
AFTER CAPTURE
SUBTERRANEAN DRAINAGE
SPRING AT CAVE OUTLET

Figure 83

Subterranean capture occurs when a surface stream is diverted underground via a sinkhole or cave.

187. SIX FLAGS-EUREKA STREAM PIRACY

St. Louis County, along I-44, between Six Flags, Allenton, and Eureka. Refer to Eureka and Pacific 7½-minute Quadrangles for piracy; add House Springs and Manchester 7½-minute Quadrangles for more complete picture.

Without a doubt, the most useful stream piracy in Missouri was that extending from a short distance east of Pacific to Eureka in a valley system now partly occupied by I-44. At one time Fox Creek, as shown in figure 84, flowed eastward past the south edge of what is now Eureka and emptied into the Meramec River in the Times Beach area. At approximately the same time the Meramec had an additional meander loop as shown by the dashed line on figure 84. This loop of the Meramec or a short tributary played a part in eroding the narrow divide separating Fox Creek from the Meramec so that Fox Creek took a shortcut into the Meramec. This shortcut may have been the direct result of erosion by the meander or it might have been a very short tributary to the Meramec which finally pierced the narrow divide. As a result of this interception, Fox Creek took a more direct route into the Meramec, following the old meander which was occupied by the Meramec at the time if the meander cutoff had not yet taken place. Whether the cutoff was before or after the piracy is not known.

When the Meramec took the shortcut, its former valley from the Allenton-Six Flags area eastward no longer was responsible for carrying its previous quota of drainage and thus became a partly abandoned valley. From the Allenton area westward, drainage was reversed so that water entering the valley now flows westward to Fox Creek and into the Meramec; from Allenton, the amount of eastward drainage is relatively small. This was a beneficial capture because the partly abandoned valley was ready-made for highway construction and very little cut and fill were necessary to accommodate an interstate highway, accompanying service roads, and two sets of railroad tracks.

A further bit of geologic serendipity was realized when the Meramec shortened itself by cutting through the neck at the south end of what is now Lost Hill. This cutoff left much of the former loop abandoned for major drainage and provided some of the area where sand and gravel deposits could be worked farther away from the active stream.

188. WARSAW STREAM PIRACY

Benton County, along Highway 65, at northeast edge of Warsaw. Refer to Lincoln SE and Shawnee Bend 7½-minute Quadrangles; add Warsaw East and Warsaw West 7½-minute Quadrangles for more complete picture.

For nearly 3 miles northward from the junction with Highway 7, east of Warsaw, Highway 65 follows a very broad stream valley. Yet those crossing the broadest part of the valley, which is nearly a mile wide in the northern part, might wonder why the highway right-of-way crosses no stream. Topographic maps give the obvious answer and the accompanying sketch (compiled from the four quadrangles listed above) gives a blimp view of geologic conditions and history.

At one time Little Tebo Creek followed the abandoned valley crossed by Highway 65 and entered the Osage about a mile northeast of the junction of Highways 65 and 7. A tributary to the Osage at the head of Kaysinger Bluff northwest of Warsaw intercepted Little Tebo, causing it to take a shortcut into the Osage, entering it some 5.5 miles upstream from its previous mouth (fig. 85).

The abandoned valley contains an excellent example of reversed drainage in Sterett Creek, which now drains westward in the abandoned valley heading at Highway 65, the complete opposite of the pre-piracy direction of drainage. From Highway 65 to the south and east, the drainage follows the same direction as it did originally but, because the stream has been robbed of much of its headwaters, it now heads at Highway 65 and is a relatively insignificant stream occupying a large valley excavated by its long-departed occupant. The backing up of the water behind Truman Dam at Kaysinger Bluff could cause a reoccupancy of this valley; thus a second dam was built across it immediately west of Highway 65 to block this undesired spillway.

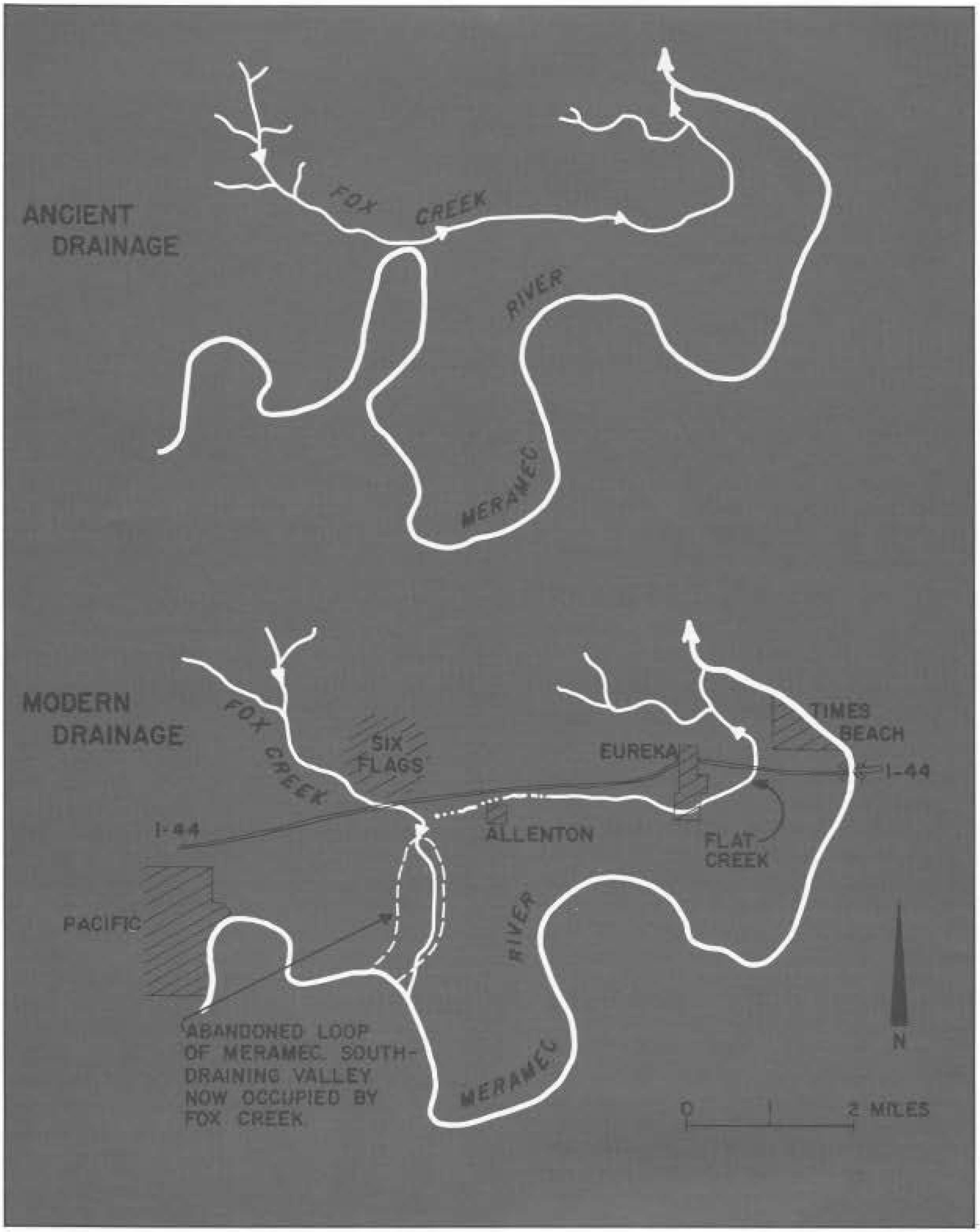

ANCIENT DRAINAGE
FOX CREEK
RIVER
MERAMEC
MODERN DRAINAGE
FOX CREEK
SIX FLAGS
EUREKA
TIMES BEACH
I-44
I-44
ALLENTON
FLAT CREEK
PACIFIC
RIVER
MERAMEC
ABANDONED LOOP OF MERAMEC. SOUTH-DRAINING VALLEY NOW OCCUPIED BY FOX CREEK
0
1
2 MILES
N

Figure 84

Ancient drainage (top) and modern drainage (bottom) of the Meramec River and Fox Creek.

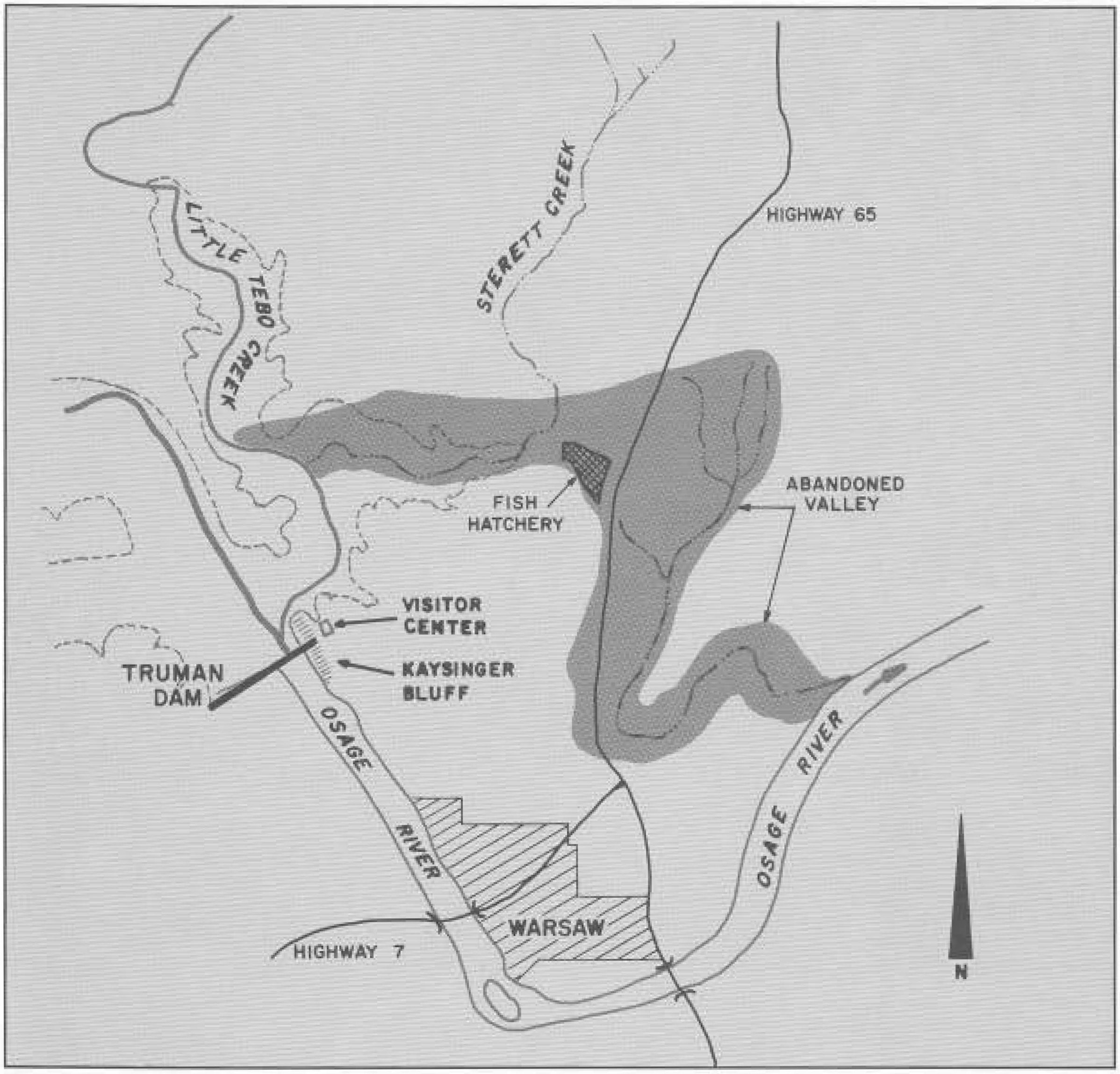

LITTLE TEBO CREEK
STERETT CREEK
HIGHWAY 65
ABANDONED VALLEY
FISH HATCHERY
VISITOR CENTER
KAYSINGER BLUFF
TRUMAN DAM
OSAGE RIVER
OSAGE RIVER
WARSAW
HIGHWAY 7
N

Figure 85

Little Tebo Creek capture at Warsaw.

189. ALGOA-OSAGE CITY STREAM PIRACY

Cole County, east of Jefferson City, near mouth of Moreau River, Osage City 7½-minute Quadrangle.

Bretz (1965, p. 110-112) and Schroeder (1971, p. 48, 52) believe the Moreau River shortened itself by at least 4 miles when it took a shortcut directly into the Missouri River instead of going through channels and utilizing the services of its volumetric superior, the Osage River. Their concept is that in the past it entered the Osage at Osage City and made its first shortening later when it meandered too close to the Missouri River immediately west of what is now Algoa and was short-circuited into it. More recently, it took another shortcut 2 miles farther upstream when it breached the narrow ridge separating it from the Missouri and entered where it now does (fig. 86).

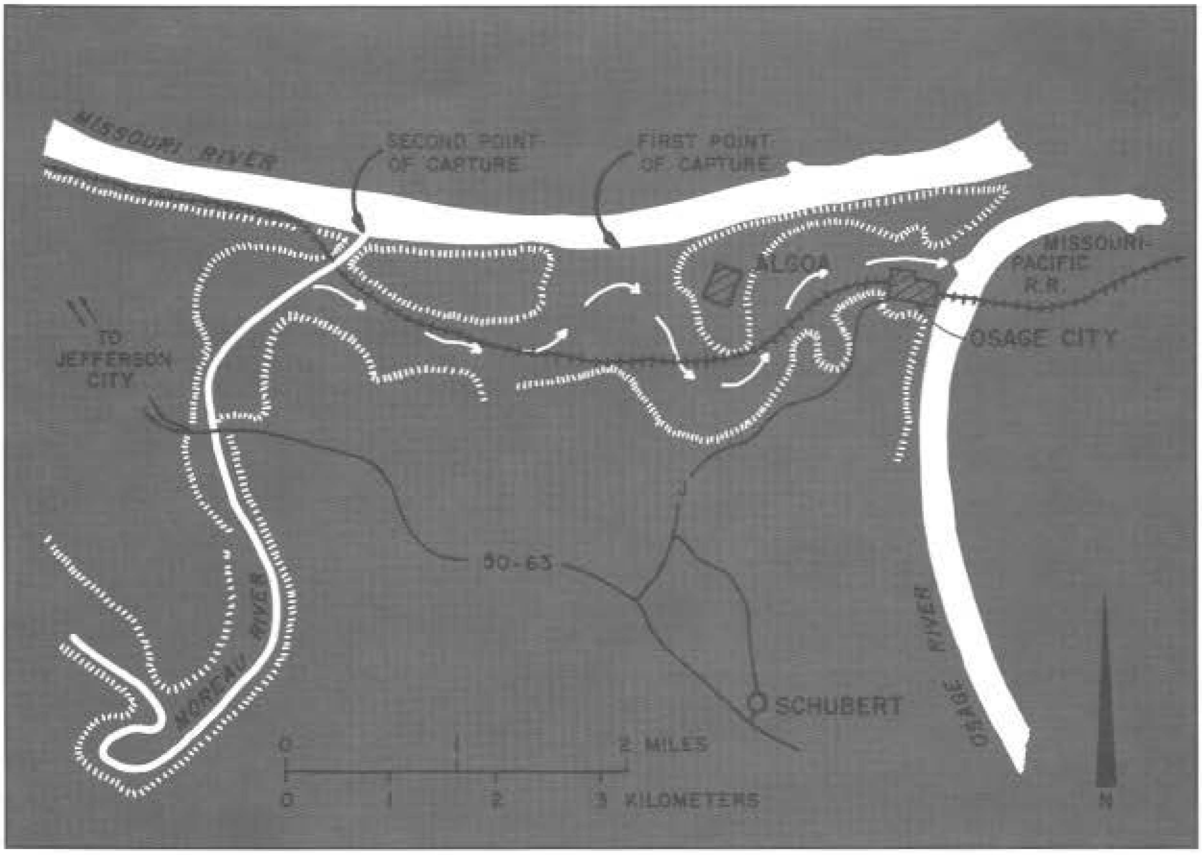


Figure 86

Moreau River capture east of Jefferson City.

Ward and Allen (1974, memo to Beveridge) question whether the ancestral Moreau ever flowed into the Osage at Osage City. They state:

"We are of the opinion that the Osage River may have carved the Osage City abandonment or that the abandonment might have been a temporary channel for the Missouri River..."

As supporting evidence, they say:

"One should note the general absence of the higher 600+ foot terrace within the Osage City sector of the abandoned valley, suggesting that a stream channel larger than the Moreau has flowed through this portion of the valley. The greater width of the Osage City sector versus the Algoa-Entrance sector supports this. Also the nature of the bluff line along the Algoa Reformatory main building area does not seem appropriate for an ancient Moreau River carving."

Which hypothesis is right? Could the Moreau have had the history portrayed by Bretz and Schroeder followed by a terrace-destroying flushing of the Missouri, or Osage, thus giving some credence to all proposals?

Regardless of what sequence it happened, the results of this piracy were, in general, good. Some excellent farmland was left behind in the abandoned valley extending from Osage City westward to the Algoa bottoms area, and the Missouri-Pacific was able to take advantage of this natural excavation for its right-of-way.

Anyone with an interest in geology who studies stream valleys of this general area should note the excellent terrace system or systems existing as a result of higher water levels of the Missouri in the geologic past. Such terraces are especially well developed in the Algoa bottoms area and along Rising Creek near the Highway 50 and 63 bridge.

190. CAPE LA CROIX CREEK PIRACY

Cape Girardeau County, south edge of Cape Girardeau, along Highways 61 and 74, Cape Girardeau 7½-minute Quadrangle.

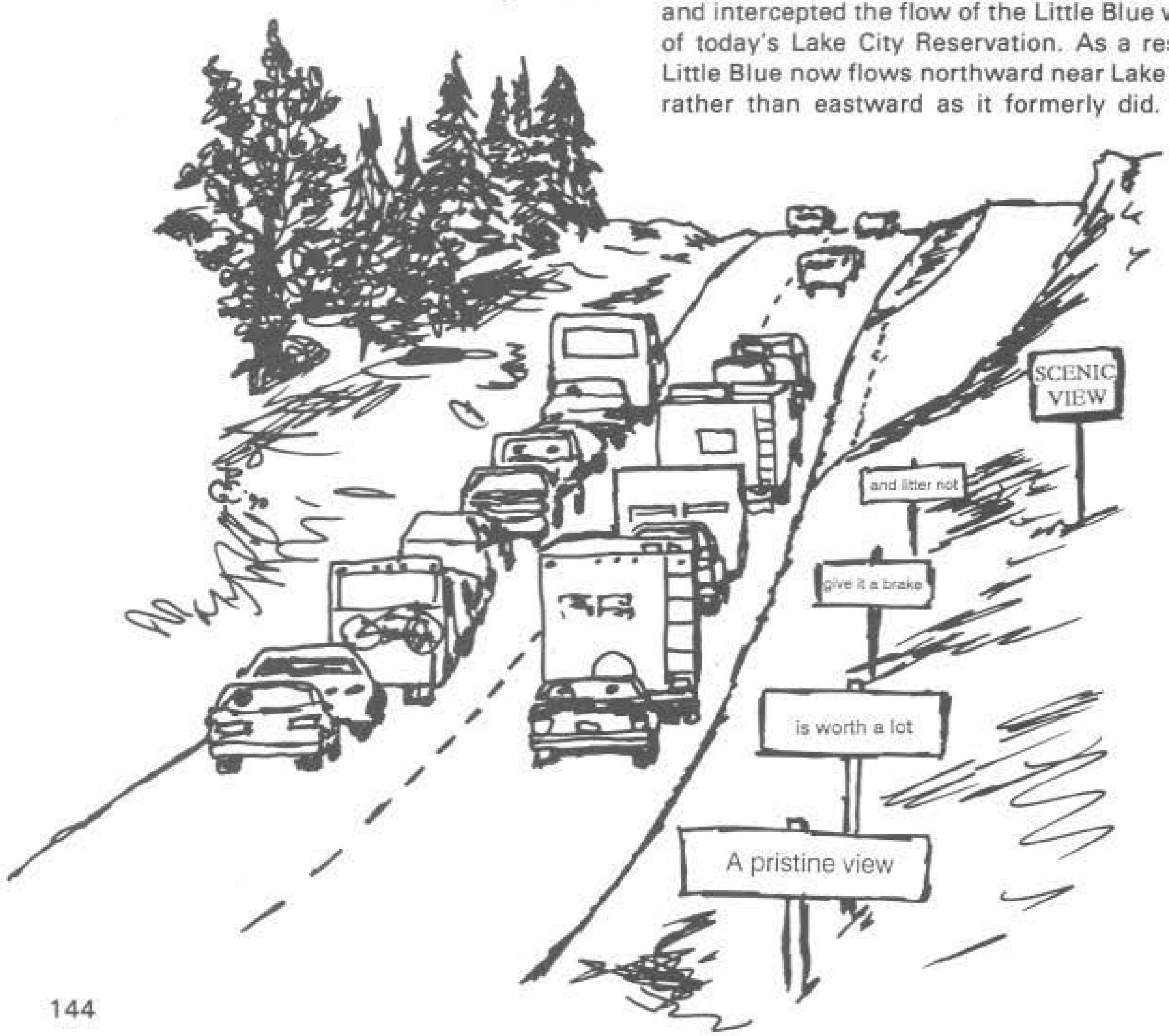
At one time Cape La Croix Creek followed the course shown on figure 87 and emptied into the Mississippi River at some undetermined point below where it now does. A tributary to the Mississippi intercepted it about 0.75 mile northeast of the present junction of Highways 61 and 74 and diverted the drainage to the present course, leaving an abandoned valley which has been utilized by the two highways almost to their junction with I-55.

The former course of Cape La Croix can be traced no farther southward than the present I-55 and Highway 74 junction because it entered what is now the northern extremity of the Southeastern Lowlands which also have a very complex history of stream piracy and drainage changes. As a result we see only the upper part of the beheaded stream but can be thankful for the free excavation work which provided a partly abandoned valley for highway right-of-way.

191. LAKE CITY PIRACY

Northeastern Jackson County. Refer to Blue Springs, Buckner, Missouri City, and Oak Grove 7½-minute Quadrangles.

The piracy of Little Blue River involved a lengthening of a lower part of the stream rather than a shortening as is common in most cases. As shown on figure 88, Little Blue formerly flowed east following the valley of Fire Prairie Creek. This valley was abandoned when a tributary to the Missouri River worked southward and intercepted the flow of the Little Blue west of today's Lake City Reservation. As a result, Little Blue now flows northward near Lake City rather than eastward as it formerly did. The



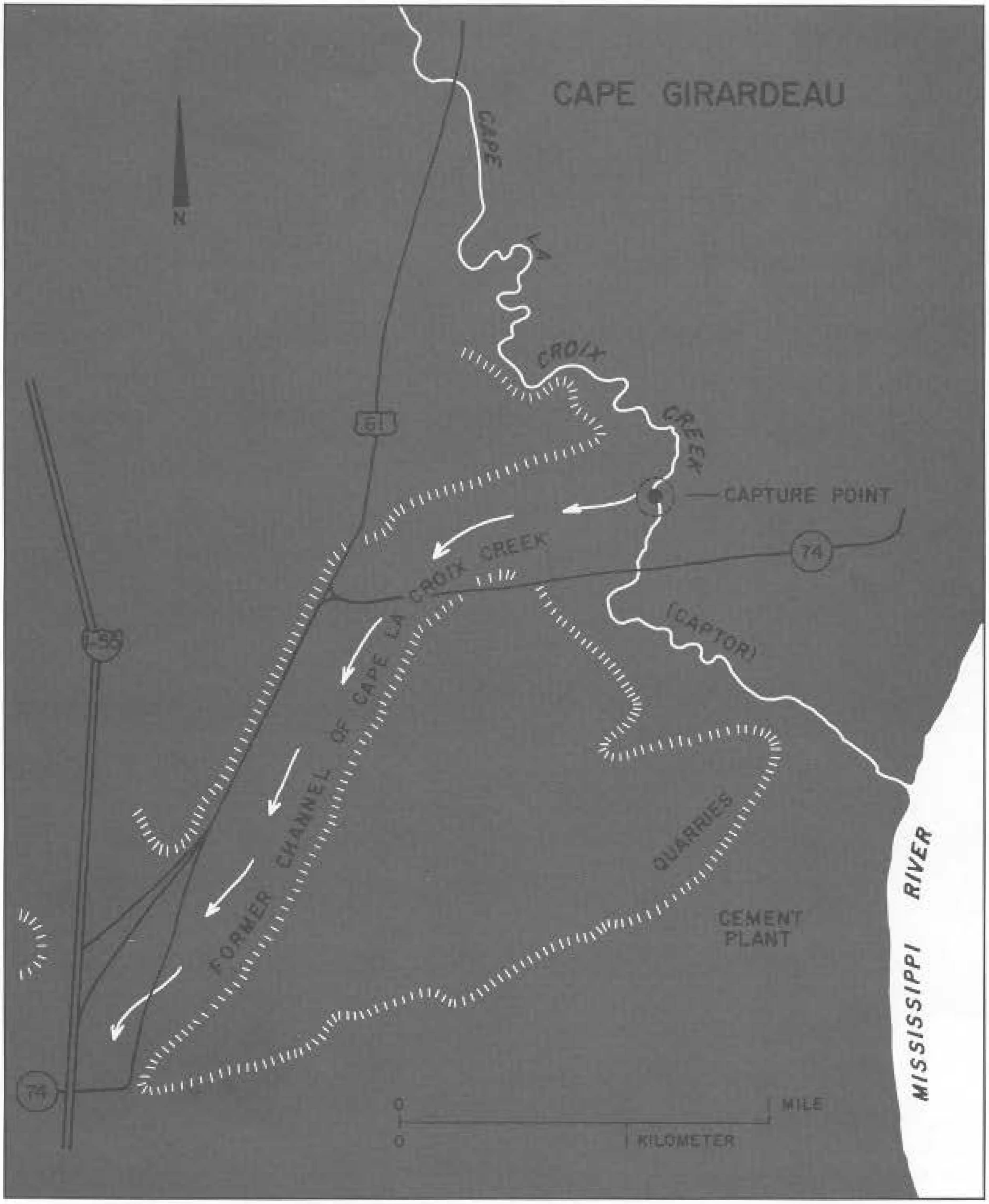

CAPE GIRARDEAU
N
CAPE LA CROIX CREEK
61
CAPTURE POINT
74
CAPE LA CROIX CREEK
I-55
(CAPTOR)
FORMER CHANNEL OF CAPE LA CROIX CREEK
QUARRIES
CEMENT PLANT
MISSISSIPPI RIVER
74
0
1 MILE
0
1 KILOMETER

Figure 87

Stream capture at south edge of Cape Girardeau.

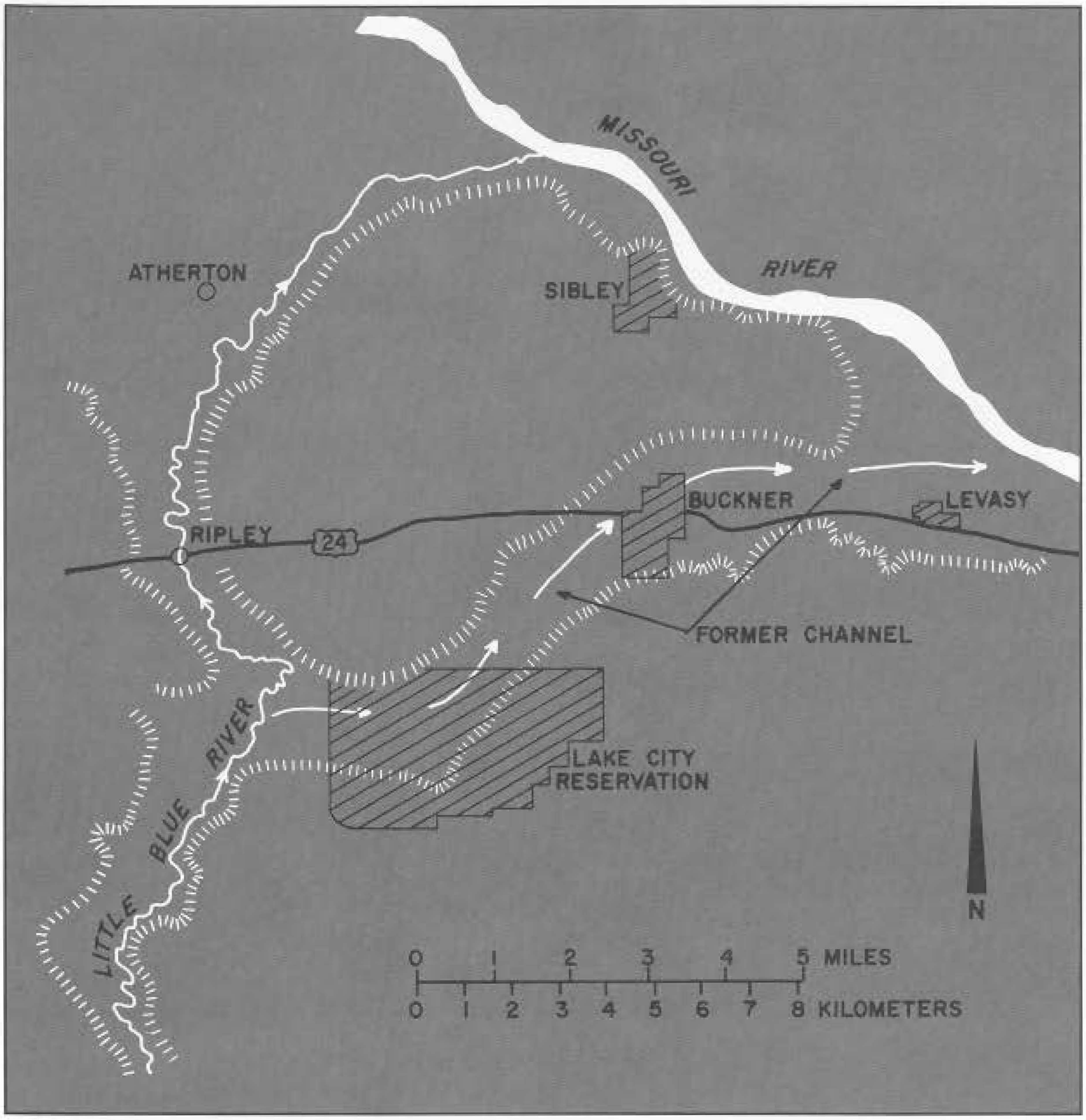

MISSOURI
RIVER
ATHERTON
SIBLEY
BUCKNER
LEVASY
RIPLEY
24
FORMER CHANNEL
LAKE CITY RESERVATION
LITTLE BLUE RIVER
N
0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS

Figure 88

Lake City piracy.

piracy has been beneficial in that both the abandoned valley and the newly created valley have been used as a right-of-way by the Missouri Pacific Railroad.

One of the evidences of the piracy is the fact that the newer valley in the vicinity of Ripley is only 0.75 mile wide whereas the abandoned valley in the Buckner area carries a much smaller stream yet is more than a mile wide. Even though Little Blue now takes a more circuitous route, the piracy has been a boon in furnishing level right-of-way for the railroad as well as for Highway 24 in the Buckner-Levasy area and a large part of the flat area within the Lake City Reservation.

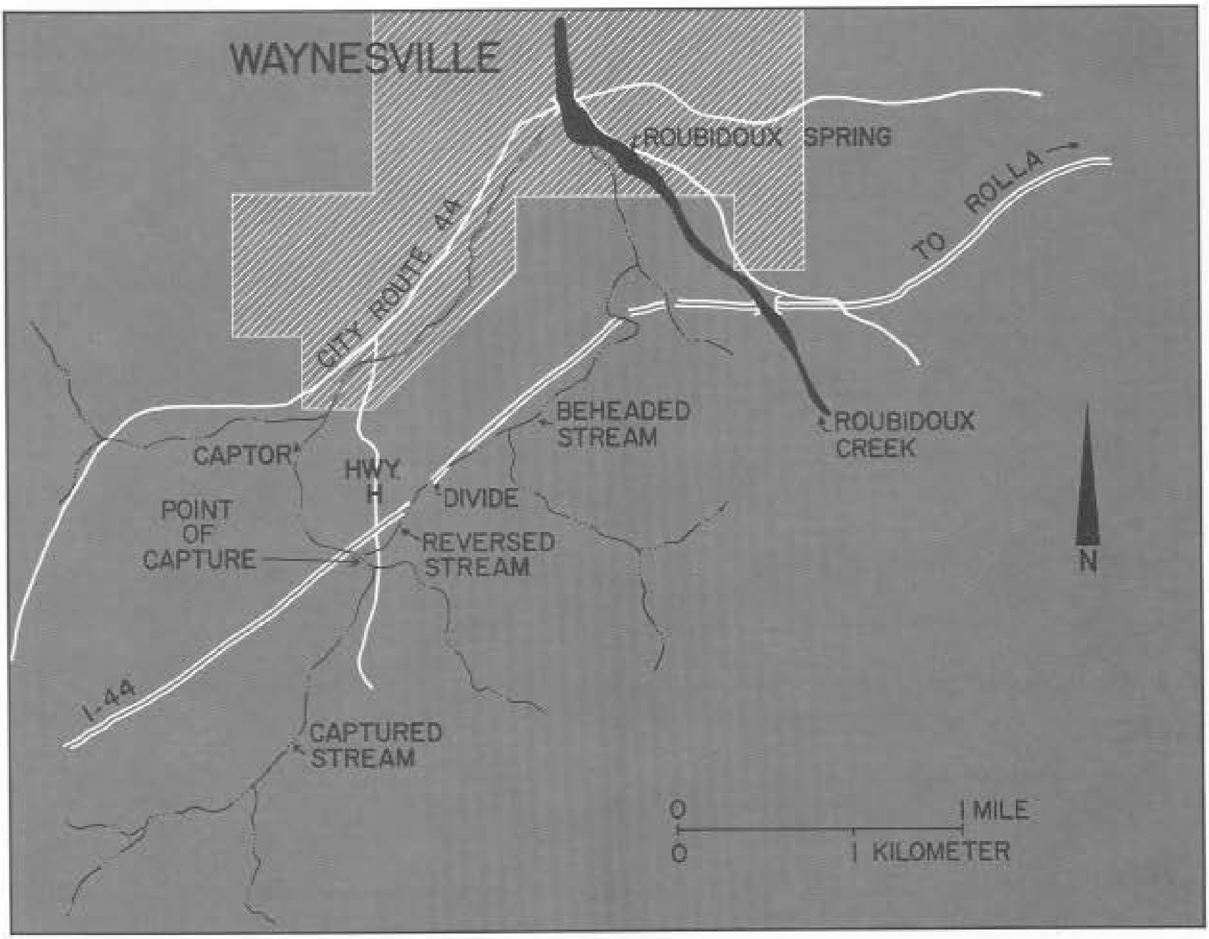

WAYNESVILLE
ROUBIDOUX SPRING
TO ROLLA
CITY ROUTE 44
BEHEADED STREAM
ROUBIDOUX CREEK
CAPTOR
HWY H
DIVIDE
POINT OF CAPTURE
REVERSED STREAM
I-44
CAPTURED STREAM
N
0
1 MILE
0
1 KILOMETER

Figure 89

Waynesville stream capture.

192. WAYNESVILLE STREAM CAPTURE

Pulaski County, southwest of Waynesville, on I-44, between Highway H and Roubidoux Creek, in SW¼ sec. 25 and NE¼ sec. 35, T. 36 N., R. 12 W., Waynesville 7½-minute Quadrangle.

The I-44 right-of-way follows a stream valley which lost much of its drainage because of piracy. After crossing Roubidoux Creek going west, the highway goes through a deep cut and then follows a broad valley to the junction with Highway H. At some time in the geologic past all of the drainage to the south of the junction with Highway H followed this valley, entering Roubidoux Creek via a steep-sided valley on the northwest side of the spur penetrated by the deep cut. However, this drainage was intercepted near the Highway H junction and now flows north and thence east along the south side of City Route 44 entering the Roubidoux at the Route 44 bridge in Waynesville. This diversion took place when the stream, near present Highway 44, worked headward and intercepted drainage near the Highway H and I-44 junction.

As shown on figure 89, a portion of the drainage in the area labeled Beheaded Stream is a reversed stream and it now flows southwest toward the H-junction rather than northeast as it formerly did.

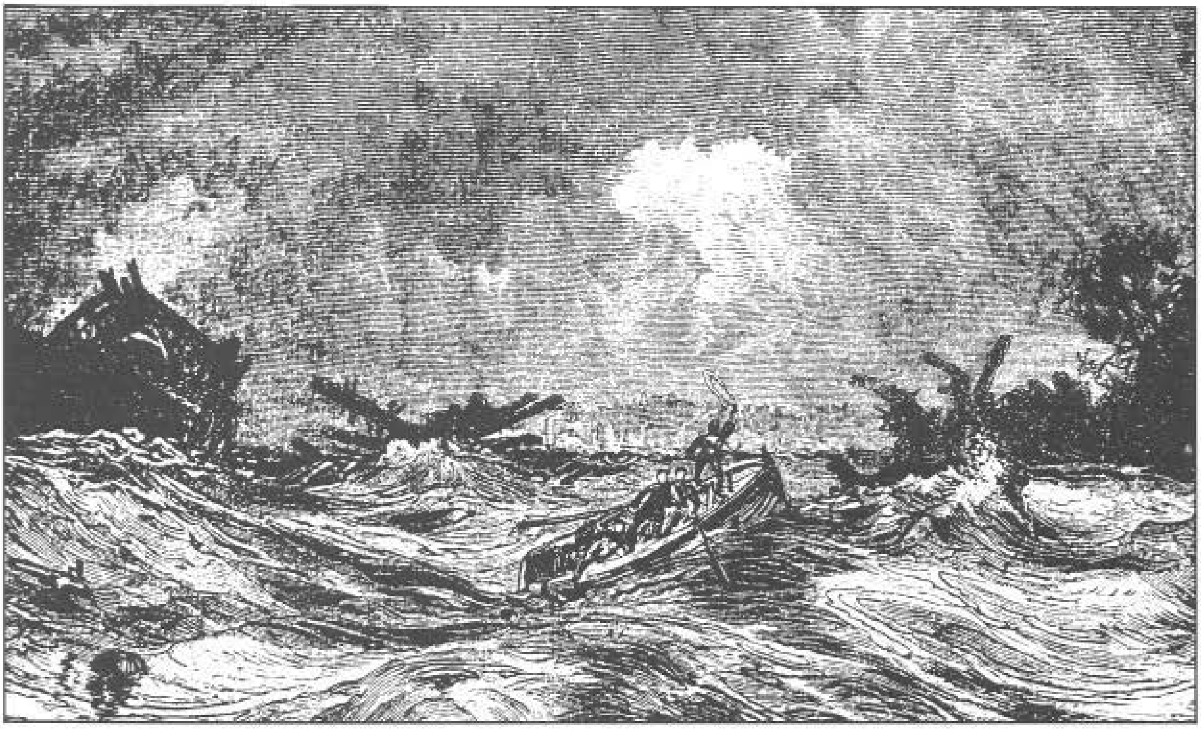


Figure 90

The New Madrid fault, believed to have caused the famous earthquakes of 1811-12, has never been seen. This drawing, "Scene of the Great Earthquake in the West," courtesy of the State Historical Society of Missouri.

8

Faults

Faults are fractures in the earth's crust involving "appreciable" (whatever that means) movement. Missouri is well endowed with faults, as shown on the *Structural Features Map of Missouri* by McCracken (1971). Only a sampling of several faults obvious to the layman is given herein, inasmuch as a complete listing would probably enervate both the writer and the reader. Many other faults are obvious to the geologist; however, one fault or fault system — the New Madrid, has never been seen but is postulated on the basis of the famous earthquakes of 1811-12 (fig. 90) and geophysical data. These earthquakes, as is the case in most famous quakes, resulted from the sudden release of accumulated strain in a fracture zone. They are dramatically described by Fuller (1912) and in an appended reprint by Magill (1958).

Most other Missouri faults are not associated with major earthquake activity within historic time. They are, however, important in determining the distribution of mineral resources and the type of rock at or near the surface and thus the soil, flora, and topography.

The following faults are obvious from the highway; many others not listed are possibly equally obvious.

193. CHESAPEAKE FAULT

Lawrence County, on I-44 between Halltown and Mount Vernon, in NW¼ sec. 8, T. 28 N., R. 25 W., Halltown 7½-minute Quadrangle.

The Chesapeake fault extends from northwestern Christian County northwestward through the southwest corner of Vernon County, Missouri and into Bourbon County, Kansas, having a Missouri portion which is nearly 90 miles long. It was delineated in detail by Rutledge (1929) in Lawrence County and is described by McCracken (1971, p. 19-20) and shown on the 1979 *Geologic Map of Missouri.* This fault is obvious on both sides of I-44 and may be seen as a major topographic escarpment by those driving southwestward along I-44 between Springfield and Mount Vernon. The escarpment, visible from at least 10 miles away, is produced by the topographically higher upthrown side of the fault on the southwest side. In the roadcut crossing the fault immediately west of the Highway N overpass, rocks dip or slope sharply with Mississippian rocks predominating on the southwest side and Ordovician rocks on the northeast side. Spring systems are quite commonly associated with faults and the Chesapeake Fish Hatchery owes its existence to such a system associated with the fault.

Serious fault finders may find the following mileages useful for orientation:

Miles

0.0 *Highway interchange south of Halltown.*

4.7 *Steeply dipping beds in fault zone immediately west of Highway N overpass.*

9.2 *Highway CC interchange.*

194. VALLEY WATER MILLS FAULT BLOCK

Greene County, near northeast corner of Springfield, extending east from Valley Water Mills Reservoir, in secs. 1-5, T. 29 N., R. 21 W., Bassville 7½-minute Quadrangle.

This fault block is roughly parallel to I-44, 0.5 mile north of the Interstate on its east end near the Highway 65 interchange. The block forms an uplifted ridge approximately 0.1 mile wide and several miles long trending slightly north of due west. The ridge is flanked by faults and is a sliver which in the geologic past was uplifted 130 feet above the surrounding strata but reduced by subsequent erosion so that its crest now rises about 50 feet above the adjacent terrain.

The conspicuous ridge has provided an attractive locale for home construction but it has been a nuisance to those attempting to drill water wells within the broken rock or "bad ground" of the fault zone. This same fault zone passes through the southern part of Valley Water Mills Reservoir and has been responsible for leakage along the west side of the impoundment. Those interested in the detailed geology of the area are referred to Beveridge (1970) for a more complete description of this fault and other associated faulting.

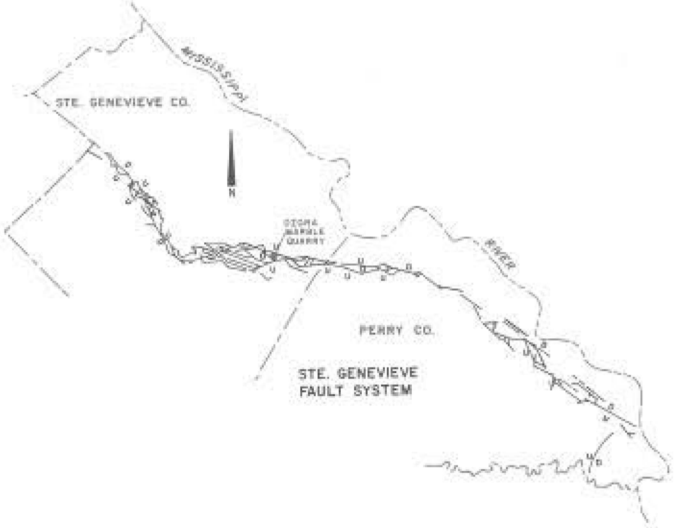
DO UNTO THE
FARMER
AS YOU WOULD HAVE
HIM DO UNTO YOU

195. PALMER FAULT ZONE

Washington County, 10 miles south of Potosi, along Highway 21, near Big River bridge, secs. 24 and 25, T. 36 N., R. 2 E., Belgrade 7½-minute Quadrangle.

The Palmer fault zone is expressed by contrasts in topography and soil types with resulting contrasts in general appearance and utilization of the land. Dake (1930, p. 181-184 and Geologic Map) described this fault system thoroughly. It is called a fault system because rather than being a single fault it is a zone approximately 2 miles wide where four faults are crossed by Highway 21. On the north side of Big River, the predominant rock type is the Eminence Dolomite and the cherty, lean soil is not conducive to farming. On the south side of Big River, faulting and subsequent erosion have brought the Lamotte and Bonneterre formations to the surface. As a result, the topography is less rugged, the soil is richer, and the area is one of attractive farms with little vegetation as contrasted with the area to the north. This great contrast is felt most impressively while driving south from Potosi on Missouri Highway 21 through the relatively rugged country, crossing Big River and suddenly entering open rolling country. The amount of vertical displacement involved in this fault system is nearly 1,000 feet, and although the layman may not see any of the individual faults he cannot miss the result of this faulting. He can, however, note the shattering of dolomites on the east side of the highway immediately north of the bridge crossing.

Dake's report is long out-of-print, but the same fault system is shown on the 1979 *Geologic Map of Missouri* and is described by McCracken (1971, p. 48). This fault system is more than 45 miles long, trending in a general easterly direction. It may be thought of as one of the north boundary faults of the St. Francois Mountains area with the upthrown side on the



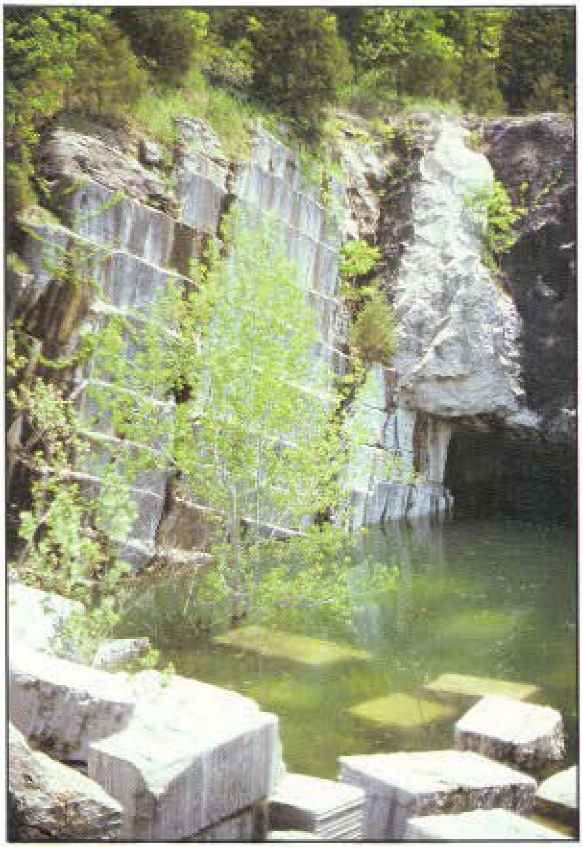


Figure 91

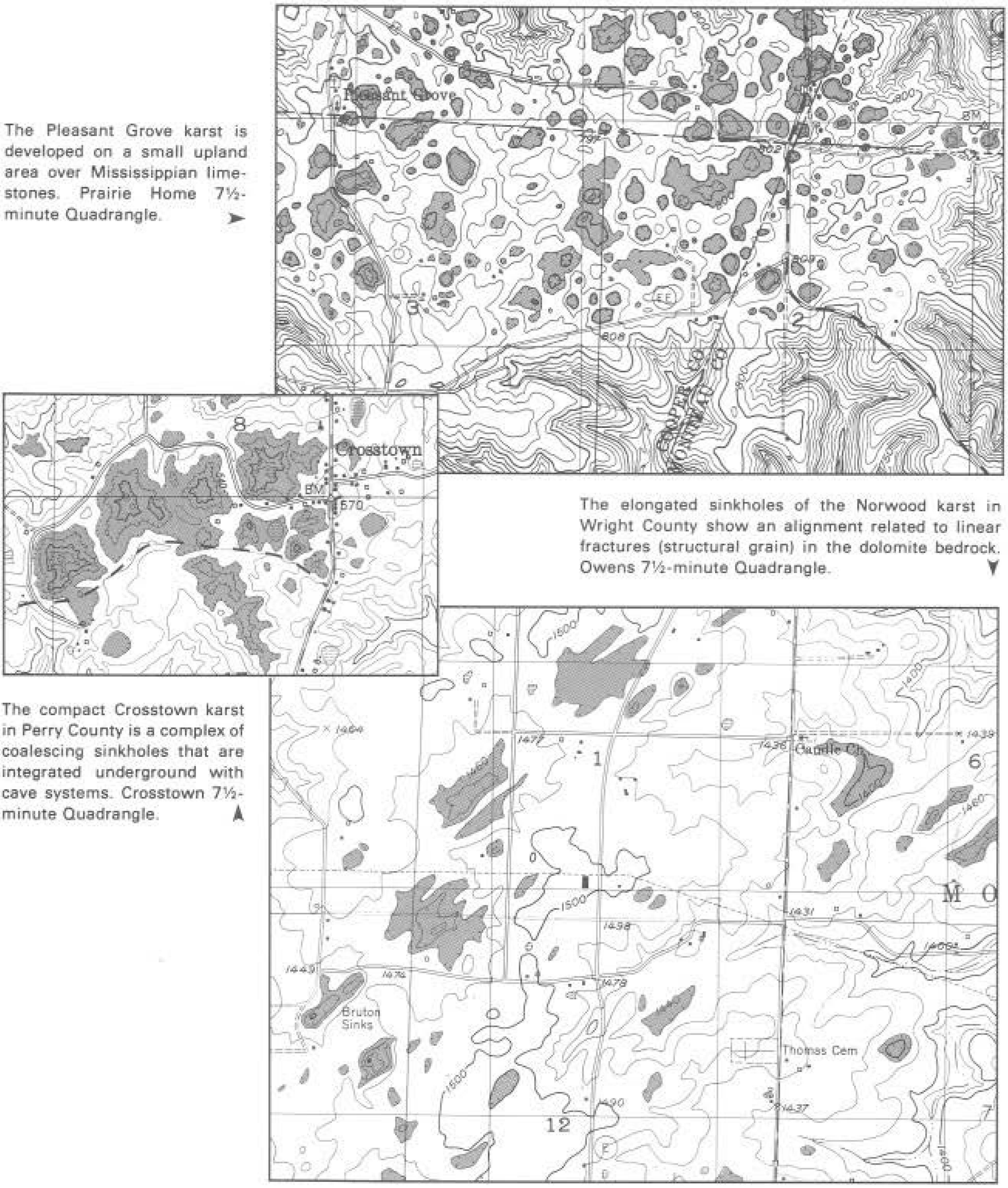
Dipping beds of Devonian limestone at the Ozora Marble Quarries are in a faulted block of the Ste. Genevieve fault system. Photo by Jerry D. Vineyard.

south where erosion has exposed the older formations and the downthrown side on the north with relatively younger formations at the surface.

196. STE. GENEVIEVE FAULT SYSTEM

Ste. Genevieve County, at I-55 and Highway Z interchange, 3 miles southwest of St. Marys (land grant area, thus no sectionalized location). Lithium, Minnith, and Coffman 7½-minute Quadrangles.

The Ste. Genevieve fault system is exceptionally complex and involves many fractures in a zone extending northwestward from southeastern Perry County across Ste. Genevieve County and into St. Francois County (fig. 91). It was described in detail by Weller and St. Clair (1928, p. 256-266) and by McCracken (1971, p. 55-57) as well as being shown on the 1979 *Geologic Map of Missouri*. A total of over 1,000 feet of vertical displacement was produced in this zone in the east-west trending portion in Ste. Genevieve County. On the south or upthrown side of this system rocks as old as Cambrian are exposed whereas on the north side Mississippian rocks are common at the surface. Interstate 55 crosses this zone at the Highway Z interchange southwest of St. Marys and the crushed, steeply dipping rocks involved in the faulting are obvious to the non-geologist. This fault system also is visible on Landsat imagery from an orbiting space vehicle nearly 500 miles above the surface of the earth. Geologic mapping from space may not provide the detail found by Weller and St. Clair but it certainly minimizes the problems of chiggers, perspiration, and brush!


Pleasant Grove
797
802
809
806
800
BM
3
2
COOPER CO
MONITEAU CO
8
Crosstown
BM
570
1500
1464
1477
1436
1439
1
6
1460
1500
1498
1431
1469
MO
1449
1474
1478
Bruton Sinks
Thomas Cem
1490
1437
12
1600
7

The Pleasant Grove karst is developed on a small upland area over Mississippian limestones. Prairie Home 7½-minute Quadrangle. ➤

The elongated sinkholes of the Norwood karst in Wright County show an alignment related to linear fractures (structural grain) in the dolomite bedrock. Owens 7½-minute Quadrangle. ➤

The compact Crosstown karst in Perry County is a complex of coalescing sinkholes that are integrated underground with cave systems. Crosstown 7½-minute Quadrangle. ➤

Figure 92

Karst topography meens a landscape pockmarked by sinkholes and underlain by soluble rocks such as limestone and dolomite. Karst areas often look as though they had undergone saturation bombing, the "bomb craters" being natural sinkholes. On topographic maps, sinkholes are usually shown by more-or-less round contour lines with little tick marks (hachures) on the inside, denoting depressions.

9

Solution Features (Karst Topography)

Karst areas are those characterized by many sinks, caves, underground streams, and large springs resulting from the dissolving action of percolating water in relatively soluble rocks such as limestone or dolomite (fig. 92). The classical karst area is the region along the Adriatic coast in Yugoslavia, which is famous for such solution features. The term "Karst" is a Germanic version of "Kras" or "Krs," the Slavic name for this area in Yugoslavia.

Rainwater absorbs carbon dioxide from the atmosphere and a weak carbonic acid is formed. As this water percolates through limestones and dolomites it dissolves them, especially along bedding planes and joints where the tendency is to develop elongated openings such as fissures and caves.

Should elongated openings be filled with water an underground stream may be formed. Should the underground stream be intersected by a valley and thus emerge at the surface in a valley wall or streambed, a spring would result. Should the roof of a cavern collapse, the result would be a sinkhole. Should the roof of a large cavern collapse over an appreciable area with one remaining portion of the roof left behind, a natural bridge or tunnel would be the result. It is obvious that many springs, caves, sinkholes, and caverns are closely related and all these phenomena could be expected in a karst area.

Some of the major karst areas of Missouri are in St. Louis, Perry, Ste. Genevieve, Cooper, Greene, Boone, Christian, Phelps, Pulaski, and Howell Counties — a listing which is not complete! The fact that Missouri contains some of the major karst areas of the world is demonstrated by the 26 commercial caves plus more than 5,000 noncommercial or "wild" caves which have been cataloged. The major springs of the state are all part of the karst system. Big Spring near Van Buren, with an average flow of 276 million gallons per day is the largest single outlet spring in the United States (Vineyard and Feder, 1974, p. 13). Missouri contains 11 first-magnitude springs (those with daily flows of more than 64,600,000 gallons).

The limestone and dolomite formations of Missouri, especially in or near the Ozarks, are highly fractured and as a result the environment is ideal for the formation of karst features. Development is further expedited by the large amounts of chert in many of these limestones and dolomites. As the carbonate rocks are dissolved, a residual mantle of relatively insoluble chert and clay is left behind. Rainwater tends to be trapped in this mantle and rather than moving laterally as surface runoff, percolates downward through the clay and chert residuum into cracks and crevices of the underlying carbonate rocks to act as a dissolving agent. As a result, many of the smaller Ozark streams do not have surface flow except during times of heavy rains and much of the water moves either within the chert mantle or in openings in the underlying bedrock. This chert mantle undoubtedly is a factor in filtering the water and assuring the clear springs which, in turn, feed clear streams.

Sinkholes, like caves, are features to be expected in areas of karst topography where dissolving of limestones or dolomites has created major voids in the bedrock. There are two major types of sinkholes. One type is caused by collapse of surface materials into an underlying void (fig. 93), and it is not uncommon to hear of the sudden development of such depressions (Williams and Vineyard, 1976). Terrifying as such an event sounds, the probability of danger to human life is remote because of the small area involved and the small number of such collapses reported. No one is known to have been injured in the state by such a collapse. The other type of sinkhole is less dramatic in its origin; it is formed by the gradual enlargement of a vertical joint or crevice by percolating waters dissolving the limestone or dolomite.

Some sinkholes are circular when viewed from above (fig. 94), especially those formed at the right-angle intersection of vertical joints; others are elongated, especially if they are developed along a major joint or by the large collapse of a cavern roof.

Sinkholes may be "good" or "bad" depending on their locations and geologic relationships. Botanists are especially fond of certain large sinks because, in many cases, they contain a unique "asylum" flora which has been isolated from the surrounding area and because the sinkholes may not have been cultivated. Large sinkholes may contain flat, fertile bottomland and thus provide oases in areas with relatively poor soil in the surrounding rocky uplands. Sinkholes often act as catch basins for water which ultimately reaches large springs. Sinkholes which have plugged themselves naturally through sedimentation hold water and thus form desirable ponds.

Figure 93

This collapsed sinkhole, south of Lebanon, had been a farm pond. The pond bottom fell out leaving a hole some 50 feet deep and 40 feet in diameter. Photo by Jerry D. Vineyard.

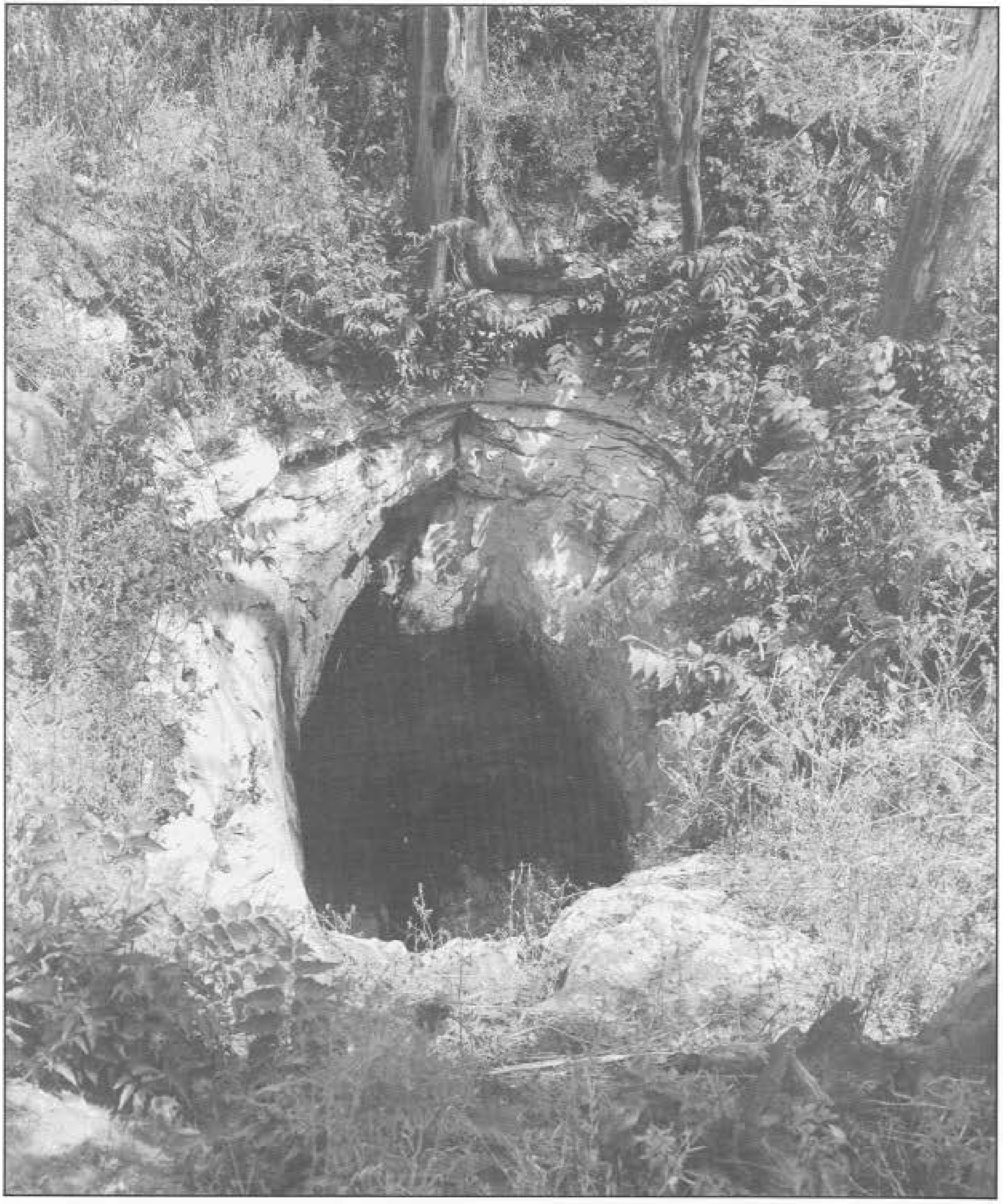


Figure 94

The Oval Sink at Southwest Treatment Plant in Springfield. Note bedrock (Burlington Limestone) in walls of sink. Sinkholes that expose underground waterways, as this one does, are sometimes called karst windows because through them one can view the workings of ground water systems. Photo by Jerry D. Vineyard.

"FOSSIL-TRAP" SINKHOLES

197. CHEROKEE CAVE SINKHOLE
198. ENON SINK
199. CRANKSHAFT PIT

Mehl (1962, p. 33-39) describes the contributions made by sinkholes in preserving fossil remains of Ice Age animals in Missouri. A famous sinkhole (No. 197) is associated with Cherokee Cave, formerly a commercial cave in St. Louis before the entrance near the intersection of 13th and Cherokee Streets was closed by highway construction. This cave contained a wealth of peccary bones indicating that this relative of the pig was once very common. The cave associated with the sink was also used for beer storage in the past and as a natural air-conditioned underground beer garden as well as a Little Theater; as a result one of its previous names was Lemp Brewery Cave.

Another very famous sink which acted as a trap for Ice Age vertebrates is Enon Sink (No. 198) in Moniteau County (sec. 30, T. 43 N., R. 14 W.), a mile southwest of Enon (Mehl, 1962, p. 37-39). Extinct horse remains, large turtle shells, and bones of the tapir and sloth were removed from it.

An exceptional variety of remains was recovered from Crankshaft Pit (No. 199), 2 miles northeast of the junction of Big and Meramec Rivers in Jefferson County (SW¼ SW¼ SE¼ NE¼ NW¼ sec. 9, T. 43 N., R. 4 E.). Extinct forms represented included a ground sloth, giant armadillo, bog lemming, tapir, long-nosed peccary, and mastodon (Parmalee et al., 1969, p. 1-37). Although the tender-hearted might sympathize with the unfortunate creatures who fell into these two sinkholes, these cavities did preserve a fascinating record of these long-extinct vertebrates.

200. THE GLENALLEN FOSSIL VERTEBRATE SITE

(Description by Bruce L. Stinchcomb*)

Bollinger County, about 1 mile north of Glenallen near center sec. 25, T. 31 N., R. 9 E., Glenallen 7½-minute Quadrangle.

A curious aspect of Ozark geology was the finding in 1942 of part of a dinosaur tail in what were considered continental deposits of Upper Cretaceous age (Gilmore and Stewart, 1945, p. 23-29). After considerable skepticism this find was substantiated as being that of bona fide dinosaur.

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*Associate Professor of Geology, Florissant Valley Community College

In 1973 the author obtained a small grant from the St. Louis Academy of Science to do some digging into the bone-bearing site. Excavations with a backhoe and a small dozer around the margin of an old cistern were unsuccessful at first. West of the cistern a chaotic mixture of chert, dolomite, and sandstone boulders was encountered associated with steeply dipping sandstone beds, suggesting so-called rimrock of a filled sink. Excavation southeast of the cistern encountered a wealth of vertebrate material contained in a gray to blue-gray, plastic clay containing pebbles of dolomite and gray chert. Large boulders of a buff quartz sandstone are also incorporated into the clay.

The deposit is herein considered as being a filled sinkhole, perhaps only the bottom portion of a much larger structure. Tropical, humid conditions of the late Mesozoic resulted in local solution of underlying dolomites (Cotter Dolomite) resulting in eventual collapse of the resulting cave which became filled with clay. This presented an open trap to unwary creatures traversing the wet, low swamplands. Entrapment and consequent burial in the clay offered an impervious medium which preserved nicely the bones of victims.

Rock units present at the margin of this filled sink are confusing at best. Boulders or masses from the Everton, Plattin, Bainbridge, Jefferson City-Cotter, and possibly Roubidoux formations can be identified. To the north and west of the sink deposit occur undisturbed sandstone beds of the Lower Ordovician Roubidoux Formation.

Bedding planes are absent in the clay and suggestion of movement of the clay mass at some time during the geologic past is evident.

Fossil bones are somewhat randomly scattered through the main mass of the clay so far encountered. Concentrations of black manganese dioxide occur locally as well as pockets of ferric oxide. The entire deposit is covered with 2 or more feet of a mixture of chert pebbles, yellow clay, and sand.

Various parts of the following organisms have been recovered from the clay:

Two types of turtles:
  Trionyx sp.
  ?Compsemys sp., a beaded turtle
Crocodile scute
Fish vertebrae and tail fragments of a large teleost such as *Xiphactinus* [*Portheus*]
Sauropod bones of various types
Hadrosaur?
Palaeoniscid? fragments

With the present investigations it is unknown as to what particular organism the dinosaur bones belong or how many individuals might be represented. Presumably the forms would be somewhat distinctive considering the isolated occurrence of this material from known western material.

Fossil bone, depending upon its depth of burial, is generally excellently preserved, exhibiting little mineralization and having very fresh appearance.

AGE OF THE BONE-BEARING SINK

The geologic age of this deposit is debatable. At the time of the original find in 1942 the deposits were considered to be Upper Cretaceous as marine deposits of this age exist 30 miles to the south. The bone occurrence was interpreted as being a continental deposit resulting from streams going into the late Cretaceous Gulf of Mexico. Two of the forms recently excavated suggest an older age for the deposit. The beaded turtle is characteristically an early Cretaceous form and hadrosaurs have a similar age range. From material so far obtained the age of the deposit could be anywhere from late Jurassic to late Cretaceous. Some of the sediment on washing and separation of different density fractions in bromoform yielded palaeoniscid? fragments, teleost fragments, and wood fragments (Frank Winter, Washington University, personal communication). Some of this material is more suggestive of a marine or brackish water environment rather than a continental one. The possibility exists of a mixed environment perhaps some marine and some terrestrial or fresh water, with an admixture of material of different ages.

OPEN SINKHOLES

The undesirable properties of sinkholes are, in many cases, related to the desirable ones. Although a sinkhole may form a natural pond in one instance, its presence in a reservoir area may cause serious loss of water and site evaluation; therefore the construction of major dams must include the consideration of sinkhole leakage.

Nature can be contrary and in cases where sinks are used to carry off surface-water drainage, it is hoped that they will not plug themselves but will act as natural storm sewers. This problem was encountered during construction of Interstate Highway 55 through Ste. Genevieve and Perry Counties. The proposed line went through a large area of sinkholes where there are no surface streams to carry drainage away from the area. The problem of disposing of any rapid runoff so that the highway would not be submerged was a major one in this environment and, in several cases, rerouting of the proposed line was necessary to assure proper drainage. The problem of whether a sinkhole will or will not act as a drainageway has inspired the proposal of a fundamental law applicable to Civil Engineering — the "Beveridge Law of Sinks." This law states that any major impoundment in an area of sinkholes will leak, but if an attempt is made to carry off surplus surface drainage into sinkholes, they will promptly stop up.

Although sinkholes have been cited as having the virtue of acting as catchment basins for surface water and feeding major springs, they also have the disadvantage of acting as sources of major pollution. Polluted water entering a sinkhole may travel underground through an open channel with very little filtration and thus pollute springs 15 or more miles away (Aley, 1969, p. 163-166; Vineyard and Feder, 1974, p. 84-91). The problem is aggravated all the more because of the human tendency to throw trash and garbage into sinkholes. Sinkholes in urban or suburban areas have been used as drainage basins for septic tank effluent. Sinkholes can also pollute nearby water wells producing from cavernous environments fed by the sinkholes. As a result, many shallow wells are known to be polluted in sinkhole areas, especially if they are not cased through the formation which has many voids. Aley et al. (1972) have described cases of long-distance contamination of springs via sinkholes and of modern sinkhole collapse in Missouri.

Springfield is nearly ringed with karst topography and has had the usual engineering problems expected with rapid growth in such an environment. Southwest of Springfield, the Wilson's Creek Battlefield National Park contains a large sinkhole which served as a temporary crypt for bodies of Federal soldiers slain in Missouri's bloodiest Civil War battle.

St. Louis and St. Louis County as well as Springfield are in the heart of sinkhole country (fig. 95) with the attendant problems of storm drainage disposal, pollution of ground water via these surface connections, and concern regarding foundations and footings.

Fortunately the Springfield and St. Louis areas have not experienced the sink collapse problems which have plagued the Farmington area, especially the Presbyterian Home for Children and the Elderly (Vineyard, 1974b, p. 182-186). Scharf (1883, p. 772-773) discusses the great cholera epidemic of 1849 and the problem of poor drainage and pollution in St. Louis. He states:

"The cholera made its appearance early in January and was undoubtedly stimulated by the wretched sanitary conditions of the city. In those days topography of St. Louis was very different from what it is at the present time. There were sink-holes where level streets now extend, and knobs, mounds, and hillocks. As the neighboring grounds were cleared away and plowed over, and there began to be an accumulation of garbage in the city which was necessary to remove, the great sinkholes that used to gape over the surface from 8th Street to 20th Street and from Chestnut to Salisbury Streets, became dumps, and their outlets became obstructed. In course of time the city was surrounded by stagnant ponds which turned green in summer, and from their fetid waters wafted the breath of the dreadful malaria. For years St. Louis was noted far an near as the 'sickly city,' and men avoided it, travelers hastened their journeys, and businessmen from abroad pressed their affairs to a speedy conclusion and hastened away from the place."

201. KAYSER'S LAKE

"Among the most noted of these poison laboratories of which St. Louis was afflicted a century ago was that situated about where there were Eleventh and Twelfth and O'Fallon Streets and Cass Avenue extending north of the last-named street for nearly a block. It was a very large pond, and the basin of a sinkhole whose outlet had been stopped up; and it was a very ugly body of water which in summer changed to a yellow-green, and emitted vapors freighted with chills, fever, and death. Means to drain it were effectually demanded."

Filling this large depression was impractical in those days of hand labor and an underground sewer was a practical thing by which to accomplish the desired end. Surveys were made and "Kayser's Lake" became the location of Biddle Street sewer, the first of the great underground drainage canals with which St. Louis is supplied. This was about 1851-1852.

Scharf further states (1883, p. 773):

"...but before the streets were graded and sewers constructed, the ground was broken by ridges which cut off large districts from all direct drainage to the river, and there were, as stated above, numerous basins or depressions over a considerable area which had no natural outlet for surface water except through sinkholes and crevices of the rock.

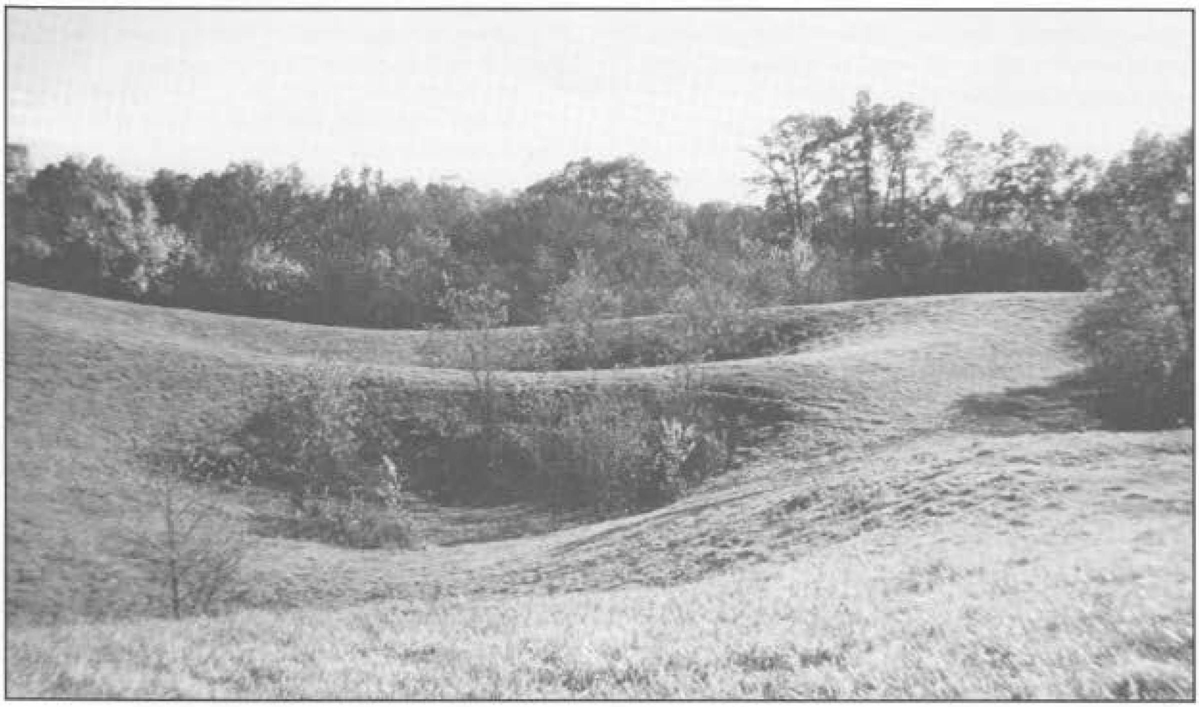


Figure 95

Sinkholes in the Florissant Karst of St. Louis County. Photo by Jerry D. Vineyard.

"These natural outlets sufficed for a time, but as the city grew and grades were established and elevations leveled off, the earth was deposited in sinkholes. Consequently the natural drains were clogged, and poison pools of stagnant water, into which most of the city's filth was swept, were created. In time as already indicated malaria was generated and, according to a local writer, 'an atmosphere of chills and fever seemed to envelope the town.' "

Scharf continues with extensive discussion of the many areas where sinkholes were a problem, a discussion which would be excellent reference material for a study of early drainage problems in the area.

The great number and variety of sinkholes in the state pose the problem of selecting those deserving special attention. The ones cited on subsequent pages are exceptionally large or are well-known locally, but many which are quite impressive have undoubtedly been slighted!

202. SINKS ROAD AND JEFFERSON BARRACKS KARST (JDV)

Sinks Road in the north part of St. Louis County is most appropriately named. It extends north from Highway 140 (Lindbergh Boulevard), a short distance east of Old Halls Ferry Road. The terrain along Sinks Road resembles heavily bombed country as the road winds between circular craters measuring from 30 to 50 feet deep. These craters occupy a very large area north of Highway 140 to the Missouri River and are quite conspicuous on the Florissant and Columbia Bottom 7½-minute Quadrangles.

Southern St. Louis County also has a conspicuous karst area that is now largely occupied by a county park, a national cemetery, and Jefferson Barracks military reservation. Once a thriving Army post occupying a strategic bluff line overlooking the Mississippi River, Jefferson Barracks has lost most of its military significance and has gained status as a fine place to view karst landforms. It is perhaps the only National Cemetery location in karst, where *"...the crosses, row on row..."* march across beautifully manicured lawns carpeting sinkholes that resemble shell craters.

The northern part of the former military reservation is now a county park, where one can view bunkers, gun emplacements, and munition storage structures in the intense karst topography. Many of the sinkholes are fitted with drainage structures to prevent ponding of water during rainy weather.

Water that drains into the Jefferson Barracks sinkholes surfaces in several springs along the Mississippi, shown in figure 96. At least two of these springs flow black water, which indicates severe pollution from landfills and septic tanks in the karst.

203. THE NORWOOD KARST

Wright County, a 3-mile radius north and east of Norwood. Owens and Norwood 7½-minute Quadrangles.

That some sinkholes follow fissures developed along fractures in rock is especially well demonstrated by this large group of parallel, elongated northeast-trending sinkholes, north and east of Norwood in Wright County. See figure 92.

204. THE SUNKLAND AND BURR OAK BASIN

Shannon County, 3 miles south of Akers and 13 miles north of Summersville, in sec. 1, T. 30 N., R. 6 W., Lewis Hollow 7½-minute Quadrangle.

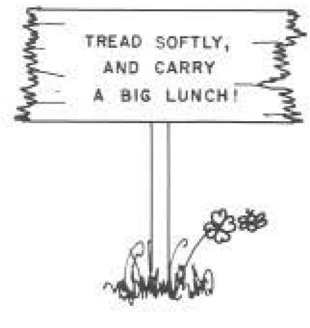
The Sunkland is the longest conspicuous sinkhole or collapse structure in Missouri, being nearly a mile long, averaging 0.125 mile wide, and as deep as 200 feet when measured from its northwestern rim. Its size and linearity conspire to put it at somewhat of a scenic disadvantage. Smaller karst features of a similar origin are quite obviously sink structures, but The Sunkland is so large that the casual observer might get the impression that it is a normal stream valley, forgetting that any drainage must be internal and that both ends of this depression are blocked.

The more spectacular and unique features of The Sunkland are visible to those descending and taking the time to explore it. Included in it are Big Yaccipin Basin, the home of the Chinquapin (chestnut), a yellow lotus lily, as well as other flora which are unique because they have existed in an unusual and isolated environment for thousands of years. The isolation did not exclude the Devil who has a den in the form of a precipitous sinkhole in an east-draining ravine in NW¼ SW¼ NE¼ SE¼ sec. 12, T. 30 N., R. 6 W.

The devotee may wish to visit the area twice, the first visit during the winter when foliage is at a minimum, undesirable fauna are dormant, and the weather has been sufficiently cold to freeze the topsoil of the jeep trails; the other visitation in the summer when desirable flora compensate for undesirable fauna (fig. 97).

The topographic map of the area (fig. 98) is a necessary navigational aid and also is instructive in portraying other sinkholes such as Burr Oak Basin, a sinkhole complex south of The Sunkland which derives its name from the oaks which once existed in these sinks but died because of natural plugging resulting in drowning of the trees.

Obviously The Sunkland visitor should plan to have plenty of time and should not anticipate using the conventional passenger car to make the entire trip. The venture is well justified and should be approached with the spirit of a true pioneer!



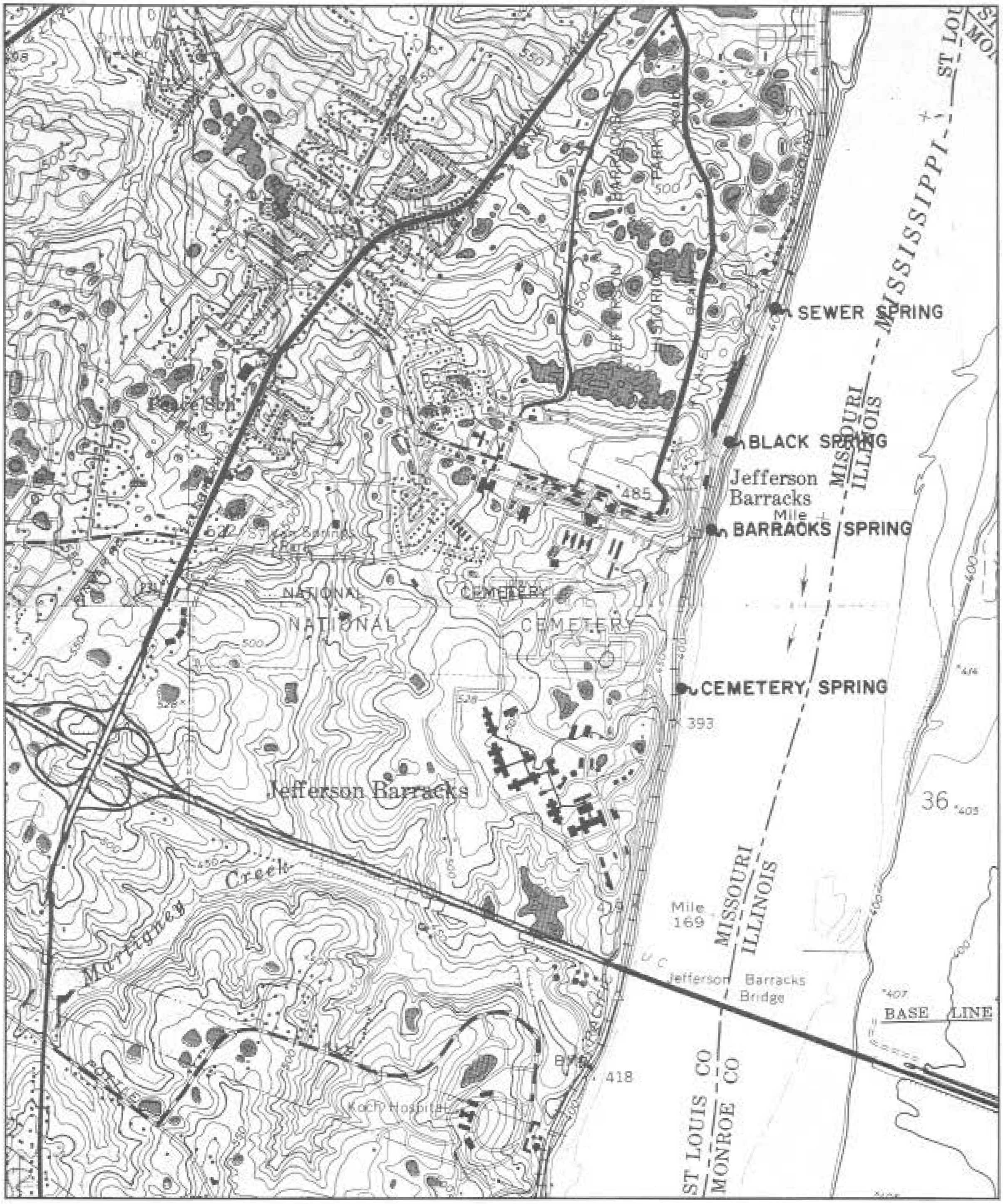

SEWER SPRING
BLACK SPRING
Jefferson Barracks
Mile
BARRACKS SPRING
CEMETERY SPRING
393
485
NATIONAL
CEMETERY
NATIONAL
CEMETERY
Jefferson Barracks
Creek
MISSISSIPPI
MISSOURI
ILLINOIS
MISSOURI
ILLINOIS
Mile
169
Jefferson Barracks Bridge
BASE LINE
418
36
ST LOUIS CO
MONROE CO
Koch Hospital

Figure 96

The Jefferson Barracks Karst as it appears on the U.S. Geological Survey's Oakville and Webster Groves 7½-minute Quadrangle maps. Sinkholes on the uplands feed water through cavernous channels to springs along the river. The riverside springs were positioned with the aid of aerial photographs.

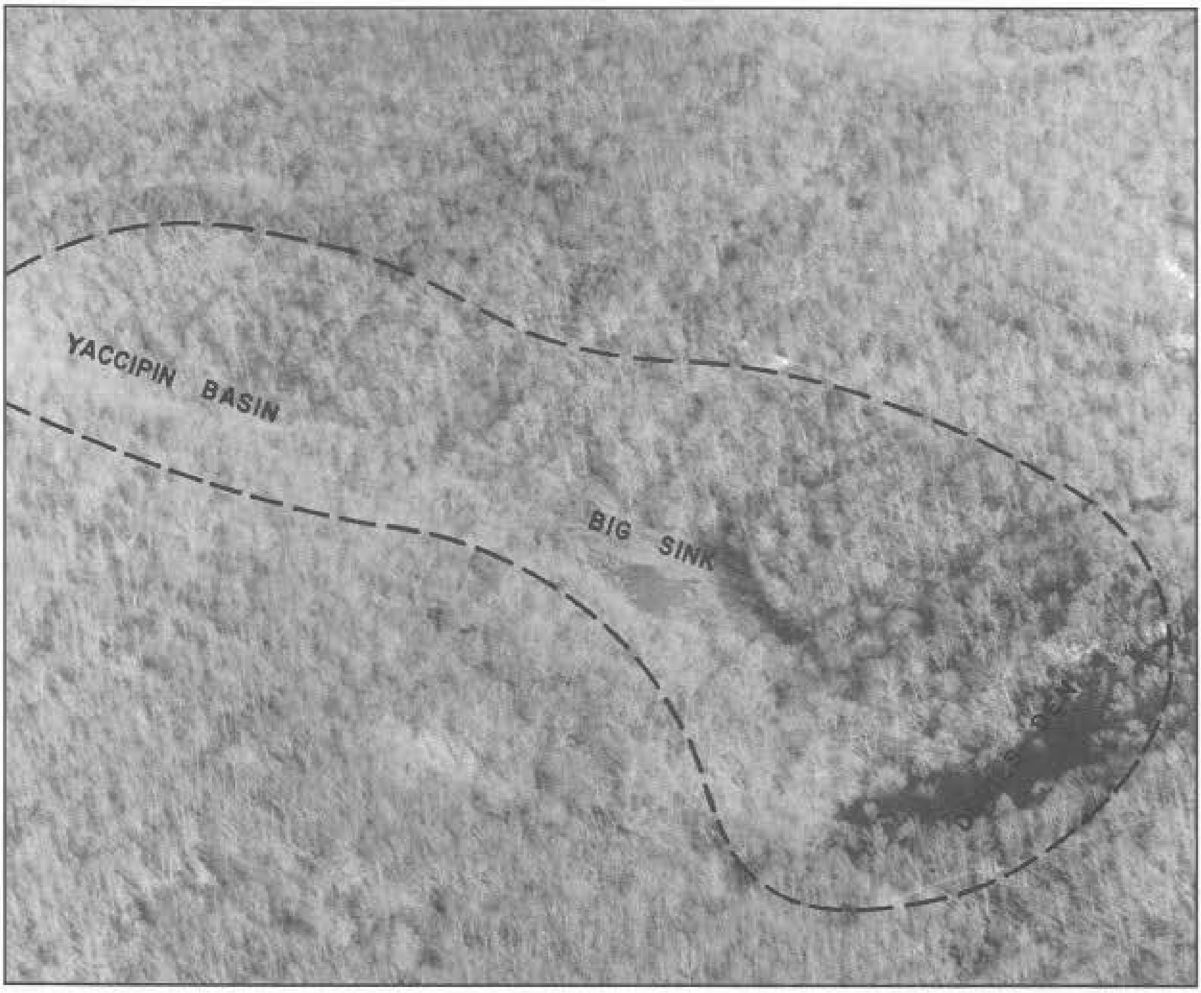


Figure 97

The Sunkland, 0.75 mile long and over 200 feet deep, is probably Missouri's largest sinkhole. Devils Den is the deepest part; it is dry, but Big Sink has a marshy lake the year-round, while Yaccipin Basin is intermittently ponded. (Place names from Perry Bryan, Winona, Missouri). Photo by Jerry D. Vineyard and James H. Williams.

205. CONICAL AND SLAUGHTER SINKS

Phelps County, west of I-44, midway between Rolla and Waynesville, in SW¼ sec. 34, T. 37 N., R. 10 W. and N½ NW¼ NW¼ sec. 3, T. 36 N., R. 10 W., Dixon 7½-minute Quadrangle.

These two sinkholes are a pair of the most spectacular in the state and have the virtue of being exceptionally close to I-44. They may be easily reached via two routes. Going west from Rolla, turn off I-44 at the Jerome (Highway D) interchange 13 miles west of Rolla. Follow the north service road west for 3 miles to the Boiling Spring gravel road. Turn right and follow it for 0.25 mile. The road is between the two sinks at this point. Those going east from Waynesville should leave I-44 on the Highway J interchange, cross over I-44, and continue east for 1 mile from the interchange to the left turn onto the Boiling Spring road.

Conical Sink, the smaller of the two, is on the south side of the gravel road and is separated from the road by a chain-link fence. As the

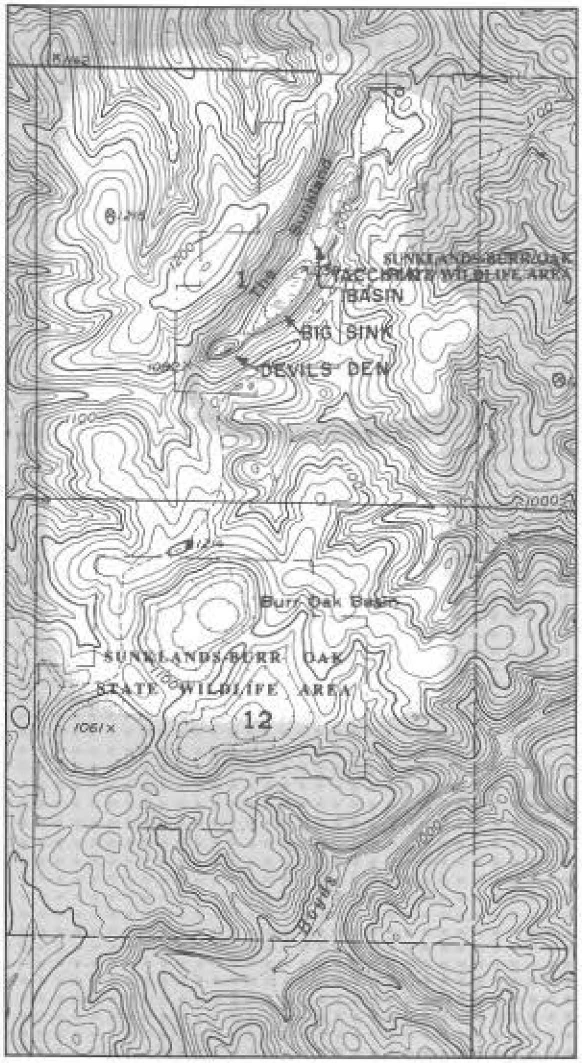


Figure 98

The Sunkland — long, narrow, and deep — contrasts with nearby Burr Oak Basin — broad, round, and shallow — but both are sinkholes. Topography from Lewis Hollow 7½-minute Quadrangle, U.S. Geological Survey.

name suggests, it is nearly conical in shape and 100 feet deep by 300 feet in diameter. Although its esthetic appeal has been diminished by its use as a trash dump, it is a most impressive structure. There is much walking fern *(Camptosorus rhizophyllus)* in the bottom and wild orchids have been reported.

Slaughter Sink is 150 yards north of the road, across from Conical Sink. It is 0.25 mile long in maximum dimension and 175 feet deep. Much of it is enclosed by vertical walls of Gasconade Dolomite. It is most spectacular in the winter when foliage is less dense or in the early spring when buds push off dead oak leaves and the redbud is in bloom.

Slaughter Sink is best approached by following the east wall of a draw which heads near the road opposite Conical Sink and drains north into Slaughter. This path terminates as a steep path leading to a promontory overlooking the sink. The promontory is pierced by a small natural tunnel (which may be entered on the west side) and capped by Roubidoux sandstone containing the polygonal ridge patterns of filled mud cracks. These features were formed as fillings of cracks formed by sediments drying on an ancient beach. One may see modern dessication cracks in dried mud and need only to imagine the image and polygons formed by filling these cracks with sand to visualize the formation of the ancient features.

The west side of the promontory, near its tip, is flanked by Chimney Rock, an erosional pinnacle of dolomite isolated by fracturing and subsequent weathering. The path to the promontory passes by large blocks of Roubidoux sandstone tumbled from the once flat-lying strata as the roof of a postulated cavern system which collapsed to produce Slaughter Sink. The floor of Slaughter is essentially flat, and the visible outlet is a small sinkhole in the floor near the north end. The sink floor is flooded when the nearby Gasconade River is in flood but this association is undoubtedly the result of heavy rains rather than backing up of river water because the floor of the sink is 145 feet higher than the Gasconade River, a mile to the west.

Both sinks were formed by solution of the Gasconade Dolomite which underlies surface sandstones of the Roubidoux Formation. As shown by the topographic map, a third sink lies to the south of Conical and is separated from it by a low saddle. These three sinks lie on a line trending N 10° E and their linear development suggests that they were created by collapse of a major cavern system. Onyx Cave, 0.75 mile to the west and Boiling

Spring, a mile to the west on the east side of the Gasconade River, attest to the area being one of karst development. Boiling Spring is most impressive as it boils out of the bed of the Gasconade River at the base of the east bluff with a measured flow of 42,000,000 gallons per day — the equivalent of 100 good municipal or industrial wells. Vineyard and Feder (1974, p. 126-127) state that *"fluorescein dye injected in Slaughter Sink traversed the channels to Boiling Spring within two days."*

206. BALL MILL RESURGENCE

Perry County, 6 miles north of Perryville, or 3 miles northeast of Brewer, near west section line, NW¼ NW¼ SW¼ sec. 24, T. 36 N., R. 10 E., Lithium 7½-minute Quadrangle.

Many sinkholes are similar to basement or storm drains in acting as conduits for carrying away water. Perry County has a chain of nonconforming sinkholes called "resurgences" which emulate some basement drains in backing up or acting as springs after heavy rains. One of these resurgences has the added unique quality of acting as a natural rock tumbler or ball mill which rounds and polishes angular rock fragments that fall into it (see Vineyard and Feder, 1974, p. 244-247).

These resurgences are at the base of bluffs on the south side of Blue Spring Branch extending from the namesake spring in the northern part of sec. 26 to Ball Mill Resurgence and beyond into the western part of sec. 24.

Ball Mill Resurgence is a basin 20 feet in diameter, which is 5 feet deep on the downstream end but has a 50-foot wall on the bluff side. Joachim Limestone fragments from this bluff fall into the basin and are tumbled by resurging water when the basin or sinkhole "backs up" after a heavy rain. Vineyard reports visiting the site when the resurgence was active and observing the natural ball mill in action. He also reports being told that after exceptional rains, the tumbling process is sufficiently noisy to be heard for a considerable distance.

The Lithium Quadrangle is in error in its location of Ball Mill Resurgence. It is almost on the line between sec. 23 and 24 whereas the quadrangle shows it as being much farther to the north and east than it actually is.

The hike from the car to Ball Mill Resurgence passes several other resurgences starting with the two small basins at Blue Spring. All of the basins will probably be dormant unless the visit is timed to accompany or immediately follow heavy rains.

Why does this system exist here and not in many other areas? An unusual plumbing system connects the resurgences with water-gathering sinkholes on the broad uplands to the south of the Blue Spring Branch valley. The connections are tubular conduits forming an extremely large cave system by dissolving action of water percolating in the limestones. The uplands are about 150 feet higher than the valley, thus the water has a considerable hydrostatic head.

Most springs in karst areas show a partial resurgence characterized by increased flow from heavy rains, but true reversible sinkholes (called estevelles by geologists) are not common. Several others are known in Missouri and more will be identified as population density and resulting monitoring of karst phenomena increases.

John Wylie, Natural History Officer for the Missouri Department of Conservation, wrote a humorous article on the Ball Mill Resurgence for the *Missouri Conservationist* magazine in July 1979, while the first edition of Geologic Wonders was in press. Wylie called it the Devil's Jump Off, and spun an imaginative yarn about the place once being a spring, but the devil, after partaking of some powerful acorn whiskey, jumped off the cliff into the spring, pulling the water in after him.

The property was acquired by the L.A.D. Foundation of St. Louis and is now leased for management purposes to the Missouri Department of Conservation. It has been designated a State Natural Area and may be visited via a marked trail from the nearest road, to an overlook above the rise pit.

207. SCHNURBUSCH KARST WINDOW (JDV)

Perry County, on the grounds of St. Joseph's Catholic Church, in the village of Apple Creek, in NE¼ NE¼ NW¼ sec. 31, T. 34 N., R. 13 E., Friedheim 7½-minute Quadrangle.

Karst topography (see discussion beginning on page 153) is especially well developed in eastern Perry County, where extensive systems of surface sinkholes, swallow holes, and karst valleys are linked to large cave systems that run beneath the surface. This hidden drainage system is seldom seen except by cave explorers, who probe and survey the extensive natural passages. Occasionally though, collapse of the roof of a cave will expose an underground stream to view; such is the case at Schnurbusch.

The term "karst window" is very apropos, because it describes an opening, or "window," through which may be seen the ordinarily hidden workings of an underground karst drainage system.

This feature is on the grounds of St. Joseph's Catholic Church in the village of Apple Creek (formerly Schnurbusch). There is a prominent sinkhole, just northwest of the church, in which an underground stream is open to view as it emerges from a low, wide cave opening, plunges over a small waterfall, and flows beneath a small arched bridge into a second cave opening (called a swallow hole because it "swallows" the stream). The entire area is tastefully landscaped, complete with walkways, plantings, bridges, and seats in the amphitheatre-like setting of the sinkhole. It is a quiet place for meditation, and an appropriate site for vespers or any other activities that are enhanced by viewing a natural wonder.

The upstream part of the karst window is low and nearly filled with water; it can only be explored by divers. The downstream, or swallow-hole end, may be followed for about 80 feet, where the stream plunges over an underground waterfall about 11 feet high, into a pool that completely fills the passage.

No measurements have been made of the flow of the stream, but in flood times (see fig. 99), the swallow hole cannot accept all the flow, and the little amphitheatre is sometimes flooded to a depth of several feet. In dry seasons, the flow shrinks to a trickle.

The water that flows through the karst window is collected in the sinkholes that pock-mark the landscape throughout the area. Dye-tracing experiments show that the water entering the swallow hole reappears about 1 mile to the southeast, in Bingenheimer Spring (Geoff Rothgeb, personal communication, 1984).

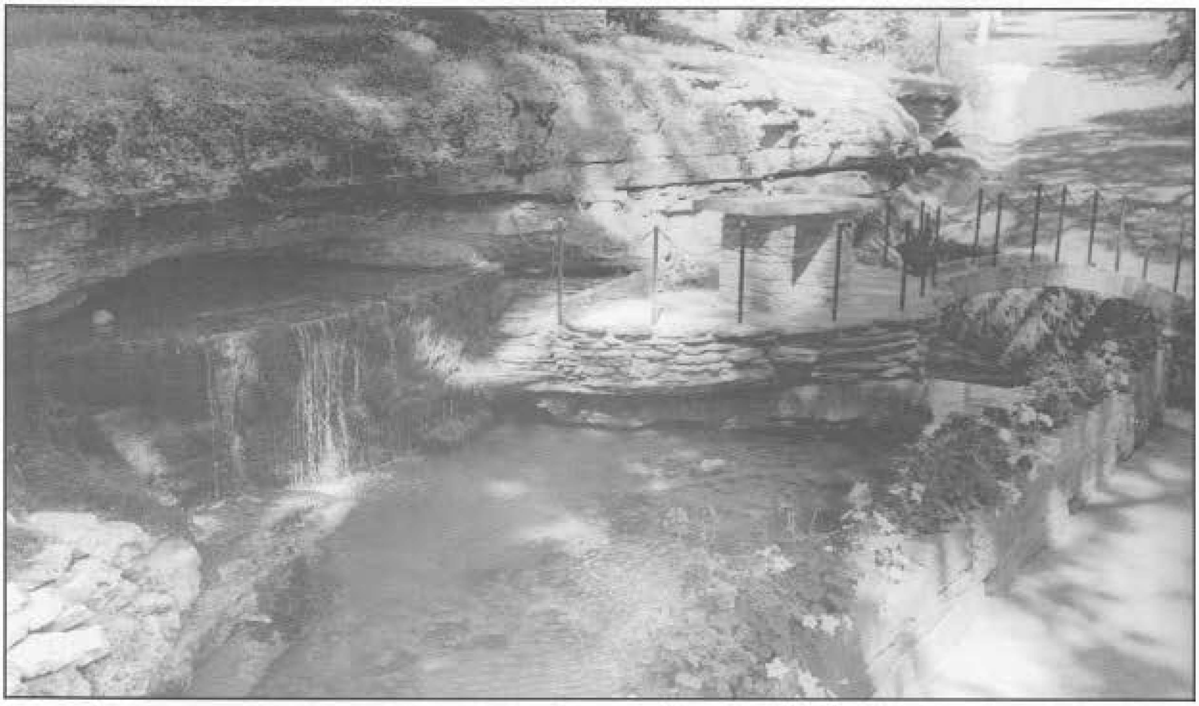
The meticulously maintained grounds are accessible to the public. The karst window is reached by parking in the church lot, then following a paved walkway into the sinkhole containing the karst window. Every consideration of respect and decorum should be observed by the visitor. Should the visitor arrive when services are being held, either in the church or in the amphitheatre, courtesy dictates a quiet exit to return at a more convenient time.

208. THE GULF

Wayne County, 3 miles south of Mill Spring, in SW¼ NW¼ SW¼ south square mile of sec. 1, T. 27 N., R. 3 E., Mill Spring 7½-minute Quadrangle.

The Gulf has been ably described by Vineyard (1970, p. 79-88) and this description is to a large part extracted from his report. The present writer had neither a boat nor a fathometer, nor the courage and skill required to make a thorough investigation, and cautiously limited himself to observations from the rim of the sink.

This sinkhole somehow escaped the name Devils Den but is also known as Blue Hole and, as Vineyard pointed out, exploration of the inner plumbing system reminds one of the Blue Grotto of the Isle of Capri (fig. 100). It is impressive from the topside view alone which is only a short drive off Highway 49. The sinkhole is a bit under 100 feet long and about 20 feet wide with an average depth to the surface of the water of about 40 feet. It extends almost due east from the road and at the east end continues as a cave with an overall surface and subsurface length



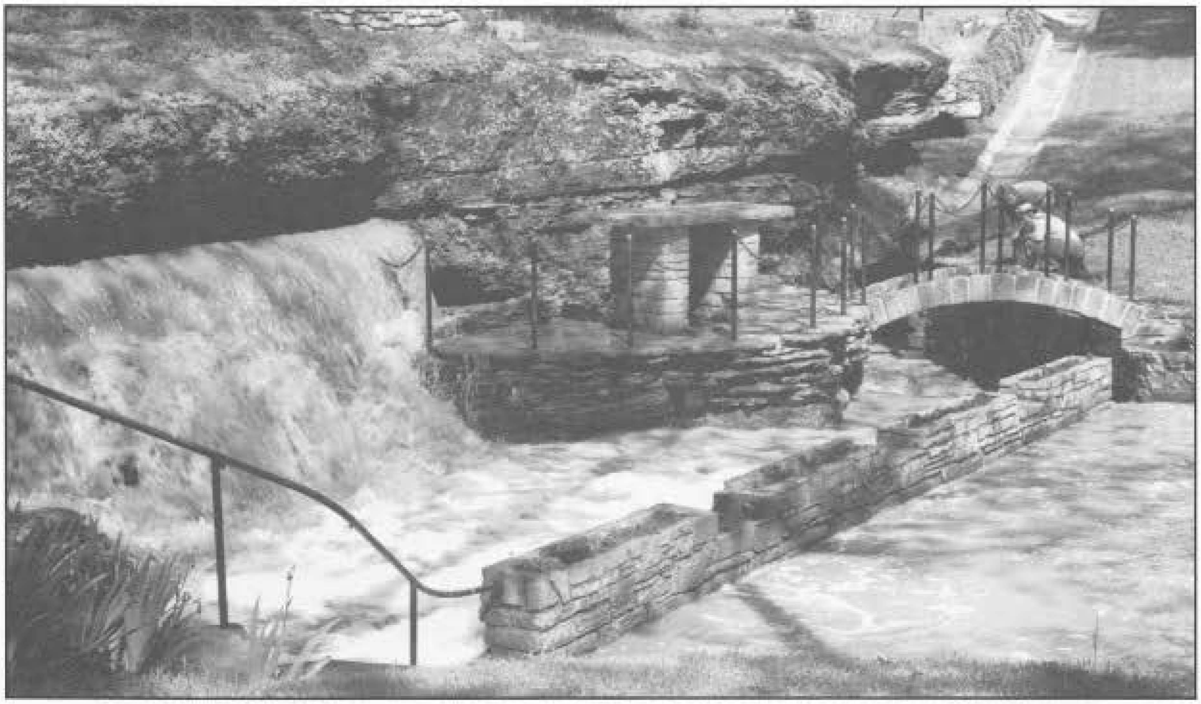


Figure 99

Photos of the Schnurbusch Karst Window in normal (top) and flood (bottom) flow show the difference rainfall can make in an underground stream. Water emerging from the cave-like opening on the left crosses the "karst window," flows under the arched bridge, and disappears underground, returning to the surface again in a spring several miles away. Photos (top) by James E. Vandike and (bottom) Jerry D. Vineyard.

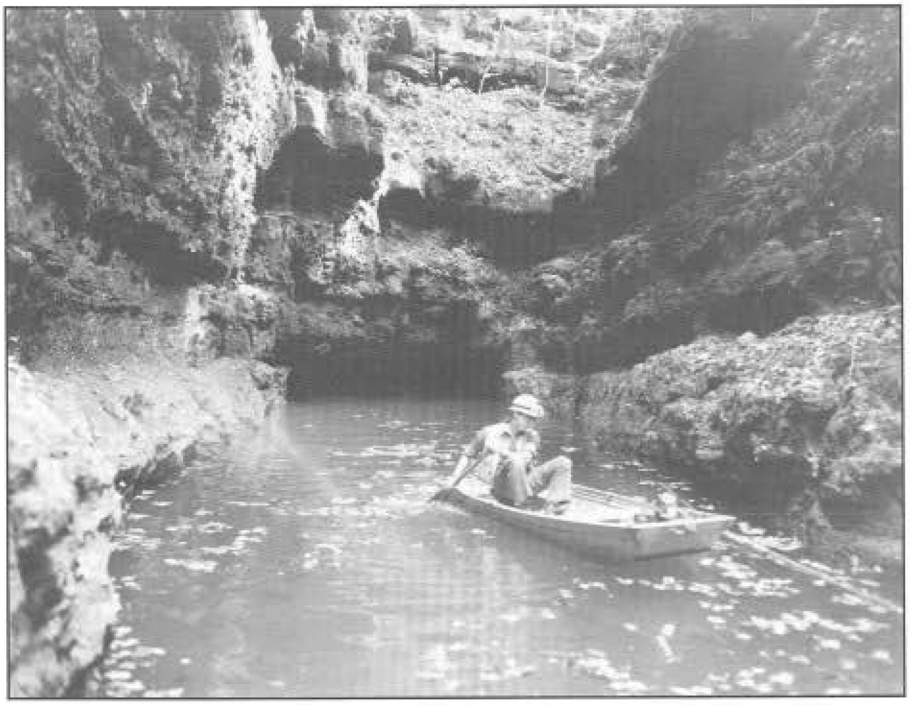


Figure 100

Deep, clear waters of The Gulf fill an incredible abyss that so far has stymied attempts by geologists and hydrologists to explain its origin and present function. In "normal" seasons, such as shown here, the water depth beneath the cave entrance in the background is over 140 feet. Photo by Jerry D. Vineyard.

of slightly over 600 feet. Vineyard and Williams explored eastward into the underground lake which widens to 80 feet in the hidden part (fig. 101). As they point out, there is no "beach" in the system and one can enter it down a steep slope on the south end but must use a boat to enter the hidden lake portion. At the time of the writer's visit, rainfall had been heavy and water was above the entrance to the lake. Vineyard reports a fathometer-determined depth in the lake of slightly under 200 feet, later confirmed by scuba divers.

Even those not having the opportunity to explore this system, will find it exceptionally attractive and also a good photo subject if the visitation is in the afternoon when the east-trending chasm is most fully lighted. Although the visible part of the site is in the Roubidoux, the water-filled portion is in the Gasconade Dolomite.

209. DEVILS DEN

Webster County, 3.7 miles west of Fordland or 18 miles east of Springfield, shown in NW¼ NE¼ NW¼ sec. 3, T. 28 N., R. 19 W., Oak Grove Heights 7½-minute Quadrangle.

Shepard's description of this sinkhole (1898, p. 38-40) exemplifies the era when a larger percentage of scientists were also interesting writers; unfortunately, his publication is long out-of-print. In the past, this feature was known as either Panther Den or Devils Den. The fact that it is in the drainage area of Panther Creek may be the reason for the contested (or allied?) occupancy.

The den is in an oak grove 400 feet due south of the stile at the end of a trail which parallels a fence to the east. This elongated

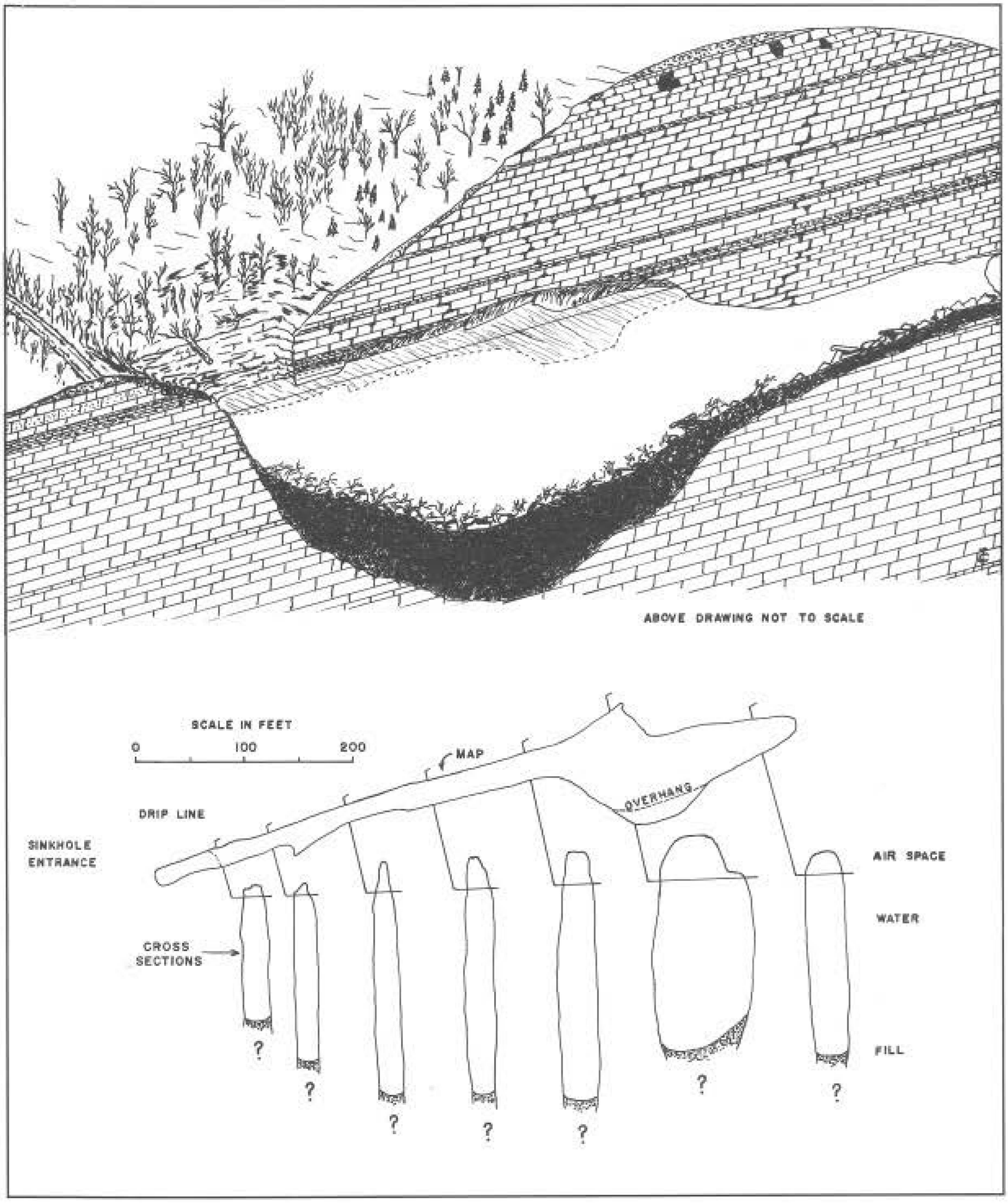

ABOVE DRAWING NOT TO SCALE
SCALE IN FEET
0
100
200
MAP
DRIP LINE
OVERHANG
SINKHOLE ENTRANCE
AIR SPACE
WATER
CROSS SECTIONS
FILL
?

Figure 101

The Gulf, a mysterious 100-foot long, 20-foot wide sinkhole in Wayne County, is the entrance to a cave with a huge underground lake. The average depth to the surface of the water from the rim of the sinkhole is about 40 feet, and the underground lake is over 200 feet deep at its maximum depth. Survey by Jerry D. Vineyard and James H. Williams; bathymetric data from soundings, fathometer survey, and scuba exploration.

chasm trends N 30° E, is 20 yards wide, nearly 100 yards long, and extends downward to the surface of the water. It is in dolomites of the Jefferson City formation and is rimmed by a more resistant sandstone.

Shepard states that the water measured 62 to 70 feet deep, thus refuting the commonplace "bottomless" legends associated with this and other chasms. He also quotes old timers describing logs being thrown in the chasm and disappearing into a cave system. The chasm may be entered for part of the way from the north end, but climbing equipment would be required for a complete descent.

Clayton (1961) states that around the turn of the century a brass band from Fordland reportedly gave concerts from the rock ledge halfway down the vertical walls and that there was *"...a railing around the rim of the canyon to prevent music lovers from toppling into a tuba."*

The den is a classic example of an elongated sink formed by the enlargement of a fracture (joint) in dolomite by the dissolving action of percolating water. It is eerie, and the explorer is in the proper frame of mind if he approaches it with some trepidation, for the hazard of a misstep is not to be taken lightly. It has been a popular picnic spot for many decades. Artifacts indicate that many modern picnickers respect the Devil and are amply supplied with liquid courage-builders.

From Fordland: Go to the junction of U.S. Highway 60 and Highway PP in Fordland and follow PP for 3.7 miles to a stile on the left-hand (south) side of the road, which is a few yards west of a lane to a house on the north.

From Springfield: Go east on Highways D, AD, and KK to the junction of KK and PP in western Webster County. From this junction, follow Highway PP east for 2.4 miles to a stile on the right-hand (south) side of the road. This stile is a few yards to the west of a lane entrance on the opposite (north) side of the road.

As suggested by the directions above, Devils Den is more easily reached via Fordland, even if one doubles back, than by driving "directly" to it east from Springfield.

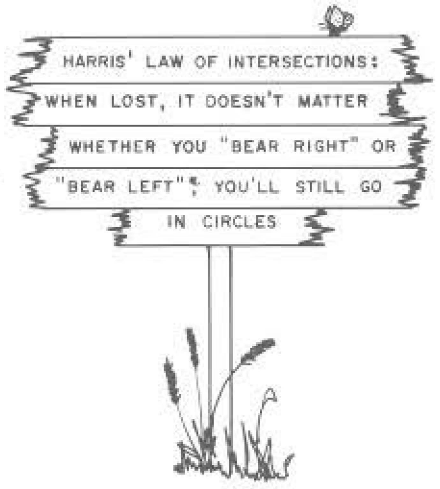
210. DEVILS WASH PAN (JDV)

Lawrence County, 5 miles west of Halltown at Comanche Springs, in NE¼ SE¼ SE¼ sec. 35, T. 29 N., R. 26 W., Halltown 7½-minute Quadrangle.

Devils Wash Pan is a classic example of a feature that geologists call a "karst window." It also fully qualifies as a wash pan for the Devil. The fact that there is only one wash pan, but many dens, bridges, wells, and other features attributed to the Devil suggests that cleanliness was not one of his virtues.

What should a wash pan for the Devil look like? When one first sees this feature, the answer is clear; it is a steep-sided, basin-shaped sinkhole with an underground stream that emerges on the southwestern end of the "pan," crosses noisily to the northeast end, and plunges underground, from whence it came. Only the Devil himself would have a wash pan supplied with constantly flowing water!

Devils Wash Pan is in a scenic area of rugged hills and narrow, steep-sided hollows well-supplied with spring water. The location is marked on the Halltown Quadrangle; look carefully between the word "Pan" and "Spring" to spot a small, closed contour with hachures (or hatchers?). This is a sinkhole that one reaches by following a trail from the parking area at Cove Spring, up the hill on the northwest side of the spring. At the top of the hill one can look directly into the Wash Pan.


HARRIS' LAW OF INTERSECTIONS:
WHEN LOST, IT DOESN'T MATTER
WHETHER YOU "BEAR RIGHT" OR
"BEAR LEFT"; YOU'LL STILL GO
IN CIRCLES

The property is privately owned and operated under the name Comanche Springs. There is a series of fishing lakes that impound the waters from several springs in the unnamed, heavily wooded hollow where the Wash Pan lies.

Geologists call this feature a karst window because it exposes to view part of an underground stream that would otherwise be hidden. The stream that crosses the Wash Pan is a principal feeder for Cove Spring, which flows from a rocky area at the base of the hill around the Wash Pan. The spring has a strong flow and supports a lush growth of watercress. It is clear that the flow of the stream through the Devils Wash Pan is not as large as the combined flow of the several outlets of Cove Spring; there must be other underground tributaries still hidden from view.

211. SUNKEN FARM SINK

Ripley County, 15 miles northwest of Doniphan, on Forest Route 3221, secs. 11 and 12, T. 24 N., R. 1 W., Handy and Bardley 7½-minute Quadrangles or Mark Twain National Forest Sportsman's Map Winona-Doniphan-VanBuren Ranger Districts.

Both topographic and Forest Service maps are useful here; the former for visualization of the topographic setting, the latter for navigation.

This gigantic sink is breached on the south end, 125 to 150 feet below the rimming upland and is one of the most accessible continuously farmed sinks in Missouri. Its maximum diameter is 0.4 mile and the owner estimates an area of 70 acres. It is an excellent example of agricultural serendipity — fertile, flat "bottomland" surrounded by relatively sterile uplands. The only drawback is that the outlet at the base of the southwest bluff, a bit over 100 yards from the barn, is slow in draining. As a result crops have been lost by flooding but the frequency is not discouragingly high.

The alignment of smaller sinks a mile to the northeast of its center suggests that the Sunken Farm may be a dramatic expression of a northeast-trending cave system. If such be the case no fragments of roof collapse remain near the surface to mar the ploughman's day. A remnant grove of trees near the north end contains some fine walnuts and perhaps an asylum flora which would enrapture botanists?

The site may be reached from Highway 60 via Highway J near Fremont, east of Van Buren and Forest Routes 3224, 3222, and 3221 in that sequence. It is closer to Doniphan and may be reached from that area by the following route if the branches are not up (low water bridges!):

Miles

0.0	*Junction Highways 60 and C, 11 miles west of Doniphan. Go north on C.*
7.0	*Turn left (west) off C onto gravel road. Follow road past Bennett community with fine log barn on right followed by stonewall on left at 8.2 miles.*
10.0	*Park at farmhouse on left where road bears right to climb hill. Sunken Farm is to right of farmhouse. Shut-In Hollow (No. 87) is less than 2 miles to the north.*

212. BUFFALO BOG

Barry County, 3 miles south of Cassville, shown in SE¼ NE¼ sec. 7, T. 22 N., R. 27 W., Cassville NW 7½-minute Quadrangle.

Buffalo Bog was not visited and we are indebted to Kennedy (1965, p. 14) for the legend of this locale. He states that the source of his information is from a reputable old-timer who in turn got his information in 1902 from the Shawnee scout, Pensatah, and that together they observed markings on the old buffalo trail and found an old oak tree that bore some of the hatchet markings preserving the essence of the legend which is as follows:

Buffalo from the Great Plains would move southward during the winter into the lowlands along the Ozark rivers for protection from the chilling winds and heavy snow (fig. 102). Ozark Indians welcomed this migration as an annual source of food and clothing and would take only enough meat and hides to supply them until the next return. In the late winter of 1776 rains were unusually heavy in the St. Francis and

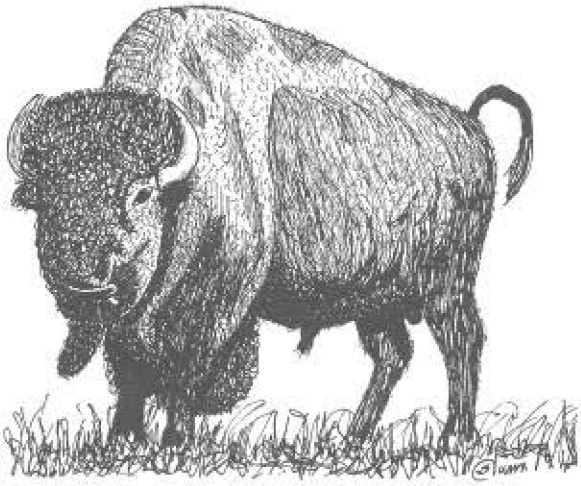


Figure 102

Buffalo from the Great Plains moved south during the winter. Drawing by Susan C. Dunn.

White River drainage areas and buffalo herds were forced to abandon their lowland grazing area much earlier than usual. Indians were disturbed at the early westward movement and immediately took action to make their annual kill. What is now Buffalo Bog was used as a basin into which a herd of more than 300 head were maneuvered so that they could be corralled and an appropriate number killed for the necessities of life. Unfortunately the heavy rains, followed by a cloudburst after the buffalo had been herded into this depression, combined to create a mire in which all of the herd drowned. According to Kennedy, *"...some 200 young Indian braves stood with heads bowed in disgrace as they viewed the wanton waste of the buffalo herd."* (It was a custom of the American Indian to kill only a sufficient number of any wild animals for his own food or clothing and never to kill the females of a useful species). He states that old-timers tell of having seen a huge mass of buffalo bones and horns in the basin.

The basin is a typical sinkhole, about 0.2 mile in diameter with the bottom 20 to 40 feet below the surrounding uplands.

The site is intriguing; has there been a recent scientifically conducted dig to check for any buffalo remains? It is near the Old Wire Road which was the main road between eastern and southwestern Missouri and followed the first telegraph line, installed in 1859. This road was the main street of Cassville and was also used by the famous Butterfield Stage Line. Cassville was the 8-day Confederate capitol of Missouri and currently has two newspapers, the *Cassville Democrat* and the *Cassville Republican*.

One route to the site is via Highway AA, 3 miles south of Cassville. From the junction with Highway 112, go west for 2 miles on AA to where it turns south. At this turn, go north for 0.5 mile. At this point, walk east 0.125 mile to Buffalo Bog.

213. DEVILS WELL

Shannon County, 11 miles northwest of Round Spring, near center north line sec. 21, T. 31 N., R. 5 W., Gladden 7½-minute Quadrangle.

In the early-1800's Dr. William Beaumont (a St. Louisian from 1839 to 1853) achieved medical fame by installing a window in the stomach of a half-breed voyager named Alexis St. Martin, using a wound in the stomach as a portal. Through this window, Dr. Beaumont studied the processes of digestion and thus turned the ill fortune of the patient into medical serendipity (Major, 1954, p. 748-751). One might think of Dr. Beaumont and his patient as he peers 100 feet vertically down Devils Well and observes part of the earth's digestive system. This system, consisting of ground water weakly charged with carbonic acid, digested Eminence dolomite to create a narrow, but spectacular sinkhole, an underground river, and Cave Spring on the Current River connected to the sinkhole by an underground river (fig. 103).

The vertical sinkhole is narrow and access to the underground river is via a bosun's chair. Because of the narrowness of the sinkhole (only a few feet in diameter in the upper part), the developer of this once-commercial enterprise (it is now part of the Ozark National Scenic Riverways) wisely limited the public to a view rather than the bosun's chair trip. The visitor does not experience disappointment at not emulating

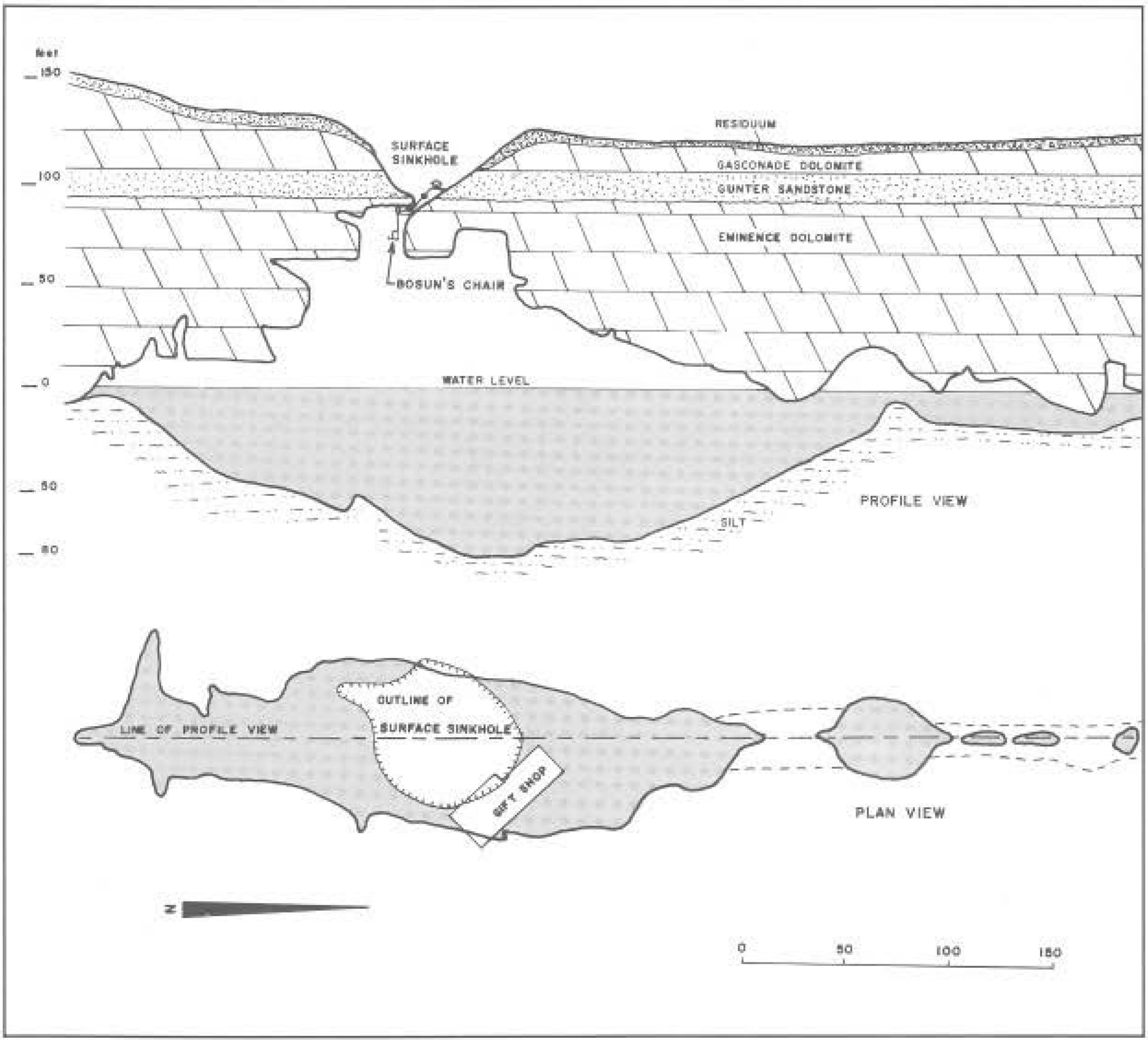

feet
150
100
50
0
50
80
RESIDUUM
SURFACE SINKHOLE
GASCONADE DOLOMITE
GUNTER SANDSTONE
EMINENCE DOLOMITE
BOSUN'S CHAIR
WATER LEVEL
PROFILE VIEW
SILT
OUTLINE OF SURFACE SINKHOLE
LINE OF PROFILE VIEW
GIFT SHOP
PLAN VIEW
N
0
50
100
150

Figure 103

Plan and profile of Devils Well in Shannon County. Surveyed by Don Rimbach and Mike Tatalovich (1970).

Orpheus, however, because lighting is so effective that the view is amply rewarding to the layman. This view is 100 feet vertically to the surface of a pristine blue or green lake which in turn is over 100 feet deep.

Blue water (such as that in the lake) exists where light is scattered by very small particles suspended in the water. It has a relatively short wave length and is scattered more than light of a longer wave length, such as red. As a result, some water, when viewed from the same side as the light source, appears blue despite not containing blue pigment. This phenomenon, called the Tyndall effect, exists only within a limited range of suspended material. If there is none, the water appears colorless; if there is much, the water is murky.

The lake, which extends out of view for 400 feet in a north-south direction, has been explored by intrepid cavers and scuba divers. Further exploration has been done experimentally using fluorescein dye which demonstrated the connection of this system with Cave Spring on the Current River, a mile to the south.

Subsequent to the visitation, the site was incorporated into the Ozark National Scenic Riverways. Thus, the foregoing describes the commercial operation as it was in the late-1960's — early-70's.

Devils Well thus gives us a rare opportunity to peek at part of the plumbing system of a major spring, with a daily flow as great as 50 million gallons. The capacity of the explored river-lake system is estimated to be in the neighborhood of 22 million gallons and thus, obviously, Cave Spring must have a larger collecting system than the one we are privileged to see. The Devils Well system represents such a unique opportunity to study karst cousins that it was the subject of a masters thesis (Vineyard, 1963) and is thoroughly described by Vineyard and Feder (1974, p. 90-103).

The view was impressive and the short drive off Highway 19 was well rewarded. This reward was further increased by original and cheerful road signs along the entrance road and the profusion of dogwood and wild flowers.

To reach Devils Well, take Highway J west from Highway 19 midway between Salem and Eminence. Two miles west of 19, turn left or south onto a gravel road and follow it an additional 2 miles to the Well.

214. DEVILS HOLE (DEVILS WELL)

Shannon County, 19 miles north of Eminence and east of Highway 19, northeast of The Sinks, in SE¼ SW¼ SE¼ NW¼ sec. 23, T. 31 N., R. 4 W., The Sinks 7½-minute Quadrangle.

The Devils Hole (the present owner calls it Devils Well, but it has been recorded and surveyed as Devils Hole) northeast of The Sinks is not commonly known to the general public and is on privately owned land where any visitation should be made only after obtaining permission from the owner. The Devil had a knack for finding old caves when sinking his wells and this one is no exception. It is a sinkhole approximately 15 feet in maximum diameter opening into a cave system 30 to 40 feet below. This cave system trends in a northerly direction for approximately 150 yards to its mouth on a northwest-facing slope. Thus the system could be considered a natural tunnel, but because the cave is not easily walked through it does not meet the restricted guidelines used in this publication for differentiating natural tunnels from double-ended caves. The view down the mouth of the Devils Hole is awesome at best and most safely enjoyed by tummy-lying on the rim. It is in the Eminence Dolomite, the most hospitable rock for karst features in Shannon County.

A serious student of geology would be interested in the very highly polished pebbles encountered in walking northwestward from the Devils Hole down the northwest slope of a ridge toward the summer home near the mouth of the cave. About halfway down this slope these pebbles, which have a much higher sheen than that produced by normal water action, are quite common. Such pebbles have been found in other karst areas and suggest a cave environment where perhaps cave clay acted as a natural jeweler's rouge and drip water may have acted as a tumbling agent.

215. KING SINK

Phelps County, 6 miles northeast of Fort Leonard Wood, on west side of gravel road, in S½ SW¼ sec. 36, T. 36 N., R. 10 W., Kaintuck Hollow 7½-minute Quadrangle (fig. 104).

King Sink is approximately 170 feet deep, 0.375 mile long, and 0.125 mile wide. Although its dimensions are comparable to those of Slaughter Sink 6 miles to the north, it is less spectacular than Slaughter because it is more elongated, thus superficially resembling a stream valley. It does not have the vertical bluffs which give Slaughter a "Shangri-La" atmosphere. As is the case in Slaughter, King Sink is developed in Gasconade dolomites, but large brown sandstone slump blocks of the overlying Roubidoux Formation have moved downslope to mantle the easily climbed sink walls.

King Sink may be reached from I-44 by taking Highway J, midway between Rolla and Waynesville. Follow it south for 5 miles from I-44 and turn left onto a gravel road at the crest of a hill. Follow this gravel road southeast for 1.9 miles

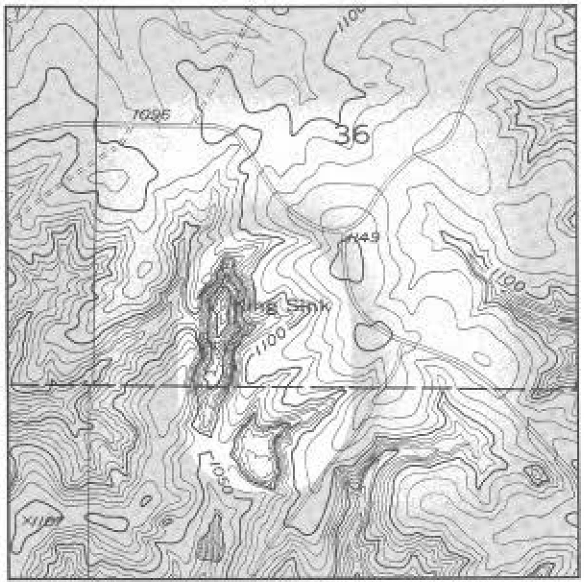


Figure 104

Steep-walled King Sink has a shallower satellite sink off its south end. Topography from Kaintuck Hollow 7½-minute Quadrangle, U.S. Geological Survey.

to a T-junction and bear right at the junction, driving 0.25 mile to a trail on the right. This trail may be driven in good weather but is not recommended when the ground is soft or for cars with low clearance. Follow the trail for 0.3 mile southwest to a fence line and open pasture. A good view of the sink is available by following the section line fence west to the east wall of the sink.

The northerly trend of the sink is aligned with the continuation of the head of a stream valley to the south, suggesting that the valley and the sink may be joint-controlled by north-trending fractures. Perhaps King Sink is a collapsed cavern and the divide between it and the stream to the south is penetrated by a cave?

A smaller, more circular sink about 200 yards in diameter may be seen to the left of the trail opposite the south end of King Sink. Even though it is relatively small it is more obvious as a completely enclosed depression than King Sink because the bounding walls may be easily seen in their entirety. This sink is 50 feet deep on the southwest side and nearly 100 feet deep on the north side.

216. FORTY ACRE SINKHOLE

Shannon County, 0.1 mile east of Highway 106, 6 miles east of Summersville, and 0.5 mile south of junction with Highway D, in N½ SW½ SE¼ sec. 19, T. 29 N., R. 5 W., Summersville NE 7½-minute Quadrangle (fig. 105).

Forty Acre Sinkhole is apparently misnamed; a rough calculation suggests that the outer rim encloses between 11 and 12 acres. Regardless of the name, this sinkhole is fairly impressive with a depth of over 180 feet and a maximum diameter of 300 yards. The visitation would be most appropriate in the winter and, even at that time, vegetation is so heavy that the sinkhole is not easily seen in its entirety.

From the junction of Highways 106 and D, drive south on Highway 106 for 0.5 mile and then bear east (left) for another 0.1 mile on a lane. At that point, the sinkhole is on the left and the best view from the lane is at the point where the road comes close to the rim of the southwest edge. Look northeast from this point to see the greater part of the sink with a steep trail leading down to it from the north side and masses of Roubidoux sandstone which have slumped into it as the underlying dolomites of the Gasconade dissolved, leading to destruction of the overlying Roubidoux. Photography would

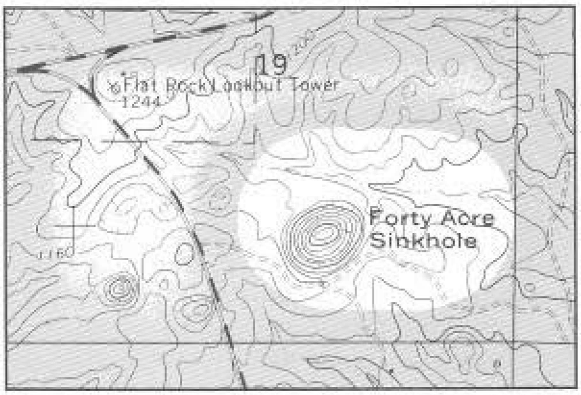


Figure 105

Forty Acre Sinkhole, part of a complex of sinks, looks as though it might have been a crater from some massive explosion, but gentle solution of rock by ground water made it. Topography from Summersville NE 7½-minute Quadrangle, U.S. Geological Survey.

not be particularly impressive here, but a visit to the Flat Rock Lookout Tower at the junction of Highways D and 106 would not be complete without the short trip to this sinkhole.

217. THE DROP-IN

Texas County, 3 miles south of Summersville, on east side of Highway 17, in S½ NE¼ sec. 1, T. 28 N., R. 7 W., Summersville 7½-minute Quadrangle (fig. 106).

The Drop-In is an area which collapsed in the 1920's, ruining a cornfield by the formation of a bog in what had been a broad stream valley and field. As shown on the topographic map, a segment of a stream valley more than 0.25 mile long is now a shallow depression which partly floods during wet weather. Local tradition holds that Alley Spring about 11 miles to the east, was muddy as a result of this collapse, a tradition which could well be true in light of the many demonstrated connections between surface drainage and major springs at greater distances. The main area is 0.5 mile south of the junction of Highways WW and 17 and 0.25 mile east of 17, 3 miles south of Summersville. Although it is not particularly impressive today, it may represent one of the relatively large areas of recorded collapse, and historical research in newspaper files of the 1920's is justified to document this meadow-to-marsh subsidence.

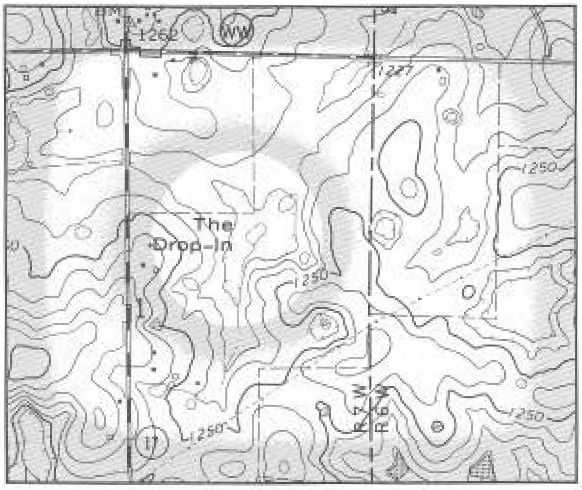


Figure 106

Once a cornfield, The Drop-In collapsed in the 1920's; local tradition holds that Alley Spring ran muddy following the collapse. Topography from Summersville 7½-minute Quadrangle, U.S. Geological Survey.

The Summersville area is well provided with sinkholes and several exceptionally large ones are shown on the same topographic map to the east of Highway JJ, 2 to 3 miles northeast of that town. Bell Flats, a mile northeast of The Drop-In, is a flat, depressed area nearly a mile in maximum diameter.

218. THE SINKS

Howell County, 2 miles south of Siloam Springs, near and on north line NE¼ sec. 17, T. 24 N., R. 10 W., Siloam Springs 7½-minute Quadrangle.

According to the topographic map, the deeper of these twin sinks is a minimum of 140 feet deep and may be nearly 180 feet deep, yet only 400 feet in rim diameter. The other sink is between 120+ and 160 feet deep and 700 feet in rim diameter. They are sufficiently prominent to gain proper noun identification on the topographic map and are a half-mile north of Highway CC.

219. DORA SINK

Ozark County, 1.1 mile (beeline) southeast of Dora, on north side of Highway CC, in center SW¼ sec. 8, T. 24 N., R. 11 W., Dora 7½-minute Quadrangle.

Dora Sink is between 80+ and 120 feet deep and 300 feet in diameter, with a conspicuous pinnacle rising from the bottom.

Underground connection between the Dora Sink and Hodgson Mill Spring is documented by Aley (1972, p. 19-22), and by Vineyard and Feder (1974, p. 168-169).

220. SNAKE PIT CAVE

Crawford County, 0.3 mile east of Leasburg, in south-draining ravine, in NW¼ SW¼ SE¼ SE¼ sec. 18, T. 39 N., R. 3 W., Leasburg 7½-minute Quadrangle.

Lack of time and a slight touch of ophiophobia did not permit visiting this locality; thus we are indebted to Rimbach (1961) for a description. This sink is a collapsed cavern as attested by the large debris pile on the floor. The rim of the sink is nearly circular and about 60 x 50 feet in diameter and the room below is roughly twice the size of the rim. According to Rimbach:

> *"There is no way to enter the pit, whose depth, from the lip to the top of the debris pile below is about 25 feet, except with a ladder. Since there is no way to climb out of the pit for man or beast, all animals which have fallen in have no way to get out. Therefore, they either die or eat the other unfortunate residents. Most of these animals are snakes."*

Although the area is reported to be excellent for copperhead collecting, Rimbach reports seeing none of these but did see 15 snakes in the pit, most of which were puffadders and garter snakes. Rimbach also reports an exceptionally large species of fern which is sufficiently healthy to support snakes who climb up on the leaves to sun themselves.

The room below the rim is oblong, running east and west with an underground lake at the west end. The lake is crescent-shaped, about 50 feet long and approximately 25 feet wide at the center. Further information (preferably second hand) regarding this pit and its contents is being sought.

221. DEVILS KETTLE

Bollinger County, 2 miles south of Highway 34 and 1 mile east of Castor River, in SW¼ NW¼ sec. 4, T. 29 N., R. 8 E., Gipsy 7½-minute Quadrangle.

Karel and Elder (1975, p. 47-48) describe the flora and fauna of this 50-foot deep sinkhole with special mention of the tulip poplars.

222. RED SINK

(JDV)

Camden County, 0.75 mile east-southeast of Hahatonka, in SW¼ SW¼ SW¼ sec. 1, T. 37 N., R. 17 W., named on Lake Niangua 7½-minute Quadrangle.

Impressive Red Sink is a slightly off-the-beaten-path part of the Hahatonka complex of karst features. From the highway near Natural Bridge, it's a 0.75-mile walk through the forest to Red Sink, but Devils Promenade (No. 339) and Devils Kitchen (No. 323) are on the way to Red Sink, so the energy-conscious visitor can see three features on a 2-mile hike.

Red Sink is so-named because it has red "rimrock" around the highest walls of the sink. However, the red color comes from thick residual soil laced with chert fragments. Around parts of the rim the slopes are so steep that the residuum does not support vegetation, and the exposure resembles rimrock.

Those persistent enough to explore the interior of Red Sink will find a large pile of cavern wreckage in the center of the sink floor, while beneath the vertical walls there are two impressive shelter caves.

The north side of oval-shaped Red Sink has been breached by erosion, leaving a saddle toward a north-draining hollow heading for River Cave. The topographic map shows 60 to 80 feet of relief below the saddle, while the high south wall of Red Sink rises nearly 200 feet above the lowest point in the sink.

Trees and brush cover the bottom of the sink and walls are precipitous. Good viewing sites are along the south rim, while access to the sink bottom is best from the saddle on the north. Difficult to photograph most of the time, Red Sink might show its best faces to the wide-angle-lens-equipped photographer who approached it in the early afternoon, when the red rimrock is exposed on the high east wall.

SINKHOLE PONDS

223. TUPELO GUM POND

Oregon County, 4 miles west of Highway 19 and 6 miles northwest of Greer Spring, between Alton and Winona, in center W½ sec. 4, T. 25 N., R. 4 W., Piedmont Hollow 7½-minute Quadrangle.

Tupelo Gum Pond is a shallow sinkhole basin about 0.125 mile in diameter, surrounded by Tupelo Gum (*Nyssa aquatica,* L.) trees which are native to marshy areas (fig. 107). This pond contains the record-size tree of this species for Missouri; one which stands 67 feet high, has a 44-foot crown, and is 7 feet 7 inches in circumference 4 feet above the ground.

The area is unusual not only for its primitive beauty (fig. 108) but also because this tree is native to the Southeastern Missouri Lowlands some 60 miles from its native marshes. Why is it here? Steyermark (1963) believes that the "foreign" flora of such sinkholes are relic species from the geologic past representing *"...the last remnants of parts of the ancient swampy peneplain that formerly existed in the Ozarks prior to its last Tertiary uplift."*

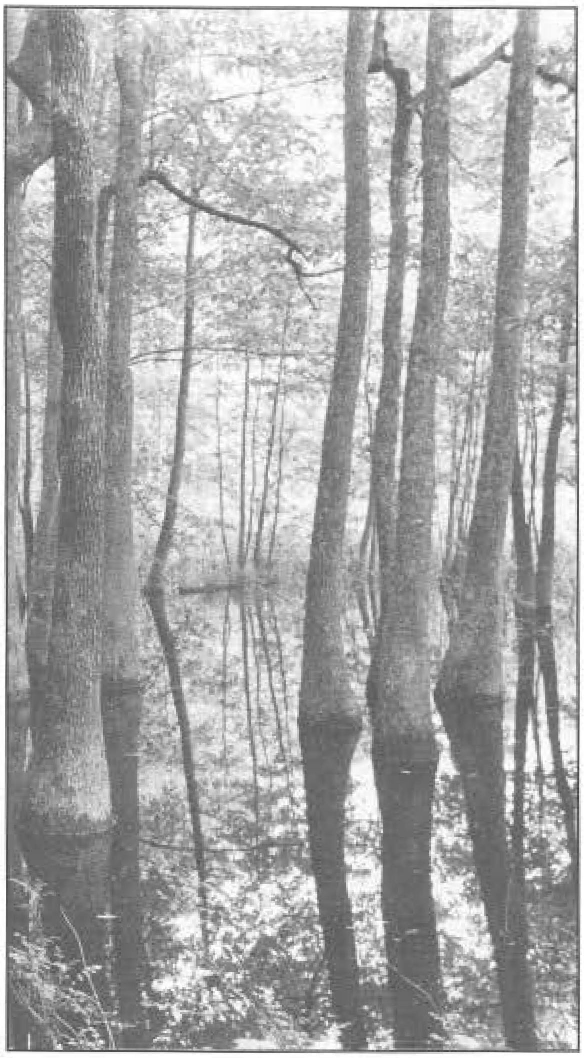


Figure 107

Tupelo Gum trees characterize the shallow 0.125-mile diameter sinkhole pond of the same name. Photo by Roger Pryor.

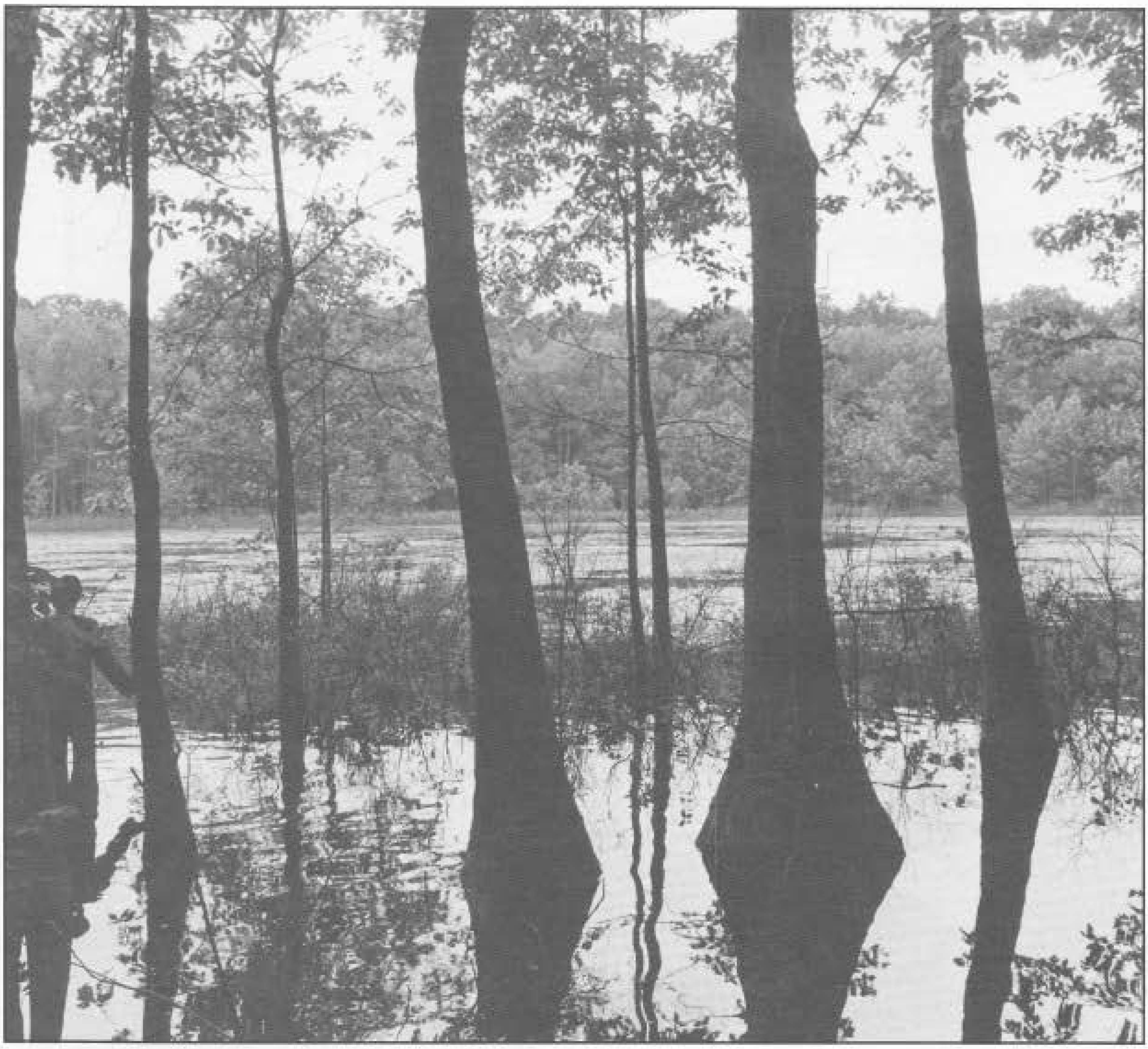


Figure 108

The primitive beauty of Tupelo Gum Pond is ample reward for those who make the effort to visit the area. Tupelo Gum trees are in the foreground; button bushes are beyond the Tupelo. Photo by Roger Pryor.

The area was not visited because of limited time, a rainy spring, and its remoteness. Those who have visited it recommend transportation which can cope with trail conditions and obtaining directions locally. The map published by the Forest Service would be most useful. A topographic map would be a welcome auxiliary and an acquaintance in Birch Tree, Winona, or Alton who is familiar with the area certainly should be cultivated. Those who have visited it have felt amply rewarded.

224. CUPOLA POND

Ripley County, in Mark Twain National Forest, 1 mile southeast of Handy or 12 miles southeast of Fremont, center of pond, in NE¼ SE¼ NE¼ SW¼ sec. 29, T. 25 N., R. 1 W., Handy 7½-minute Quadrangle.

Cupola Pond is honored by being on the National Register of Natural Landmarks and shares the honor with Tupelo Gum Pond (No.

223) of being the only two known Ozark locales for the occurrence of the Tupelo Gum Tree. Cupola Pond covers 2.5 acres of the 160-acre tract in Mark Twain National Forest. It may be reached by taking Highway J south from Fremont and then Forest Service Roads 3224 and 4822 to the left.

Cupola Pond was designated a State Natural Area in 1980.

225. BLUE POND (JDV)

Bollinger County, 2 miles southeast of Devils Kettle (No. 426), in E½ SW¼ SW¼ sec. 11, T. 29 N., R. 8 E., Gypsy 7½-minute Quadrangle.

Blue Pond is a geological enigma, apparently both a sinkhole pond and a spring. Its deep water and its setting in the Castor River State Forest make it appear as a blue jewel in the green forest. Designated a State Natural Area, Blue Pond is owned by the Missouri Department of Conservation.

Steep-walled sinkhole ponds are a familiar sight across the wide, rugged hill country of the south-central Ozarks, but Blue Pond is far to the southeast, very near the edge of the Ozarks, where the forested hills give way to the flatlands of the Southeastern Lowlands province. Nevertheless, Blue Pond may well be, at 66 feet, the deepest sinkhole pond in Missouri (Hunzeker, 1983, p. 30-31).

According to Hunzeker, local folklore traces Blue Pond to the New Madrid earthquakes of 1811-12. In earlier years, it was said to be 72 feet deep. Temperature measurements reported by Hunzeker show that the pond water is stratified; that is, it is colder at depth than at the surface. Part of the reason for temperature differences is that Blue Pond is fed by a small spring on the northwest corner. The flow is sufficient to provide, during most of the year, a small discharge from a drain in the southeast corner.

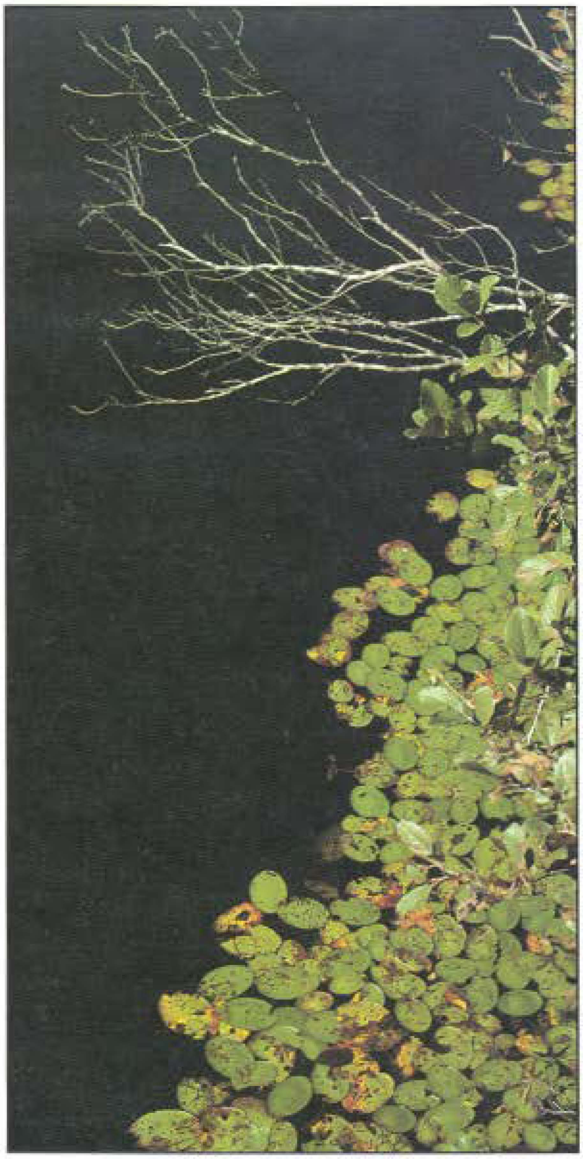


Figure 109

Water plants crowd the shallows around Blue Pond, but the water depth increases rapidly toward the center of the natural lake. Spring-fed, the pond never goes dry. Photo by Jerry D. Vineyard.

FILLED SINKS AND CIRCLES

The cliché about nature abhorring a vacuum might be paraphrased to refer to nature hating cavities. Nature responds to cavities in two ways: either she enlarges them as demonstrated in cave and sinkhole formation, or in other environments or stages of geologic processes she fills them. This filling episode is often late in the history of the sinkholes. The filling materials and methods of filling are quite varied and in some cases we still do not know the mechanics or chemistry involved. The most exhaustive published studies of filled sinks are by McQueen (1943) and Grawe (1945) on fire clays, pyrites, and iron ores, respectively. We are, however, well aware of the economic import of many of these sinkhole fillings when we consider the valuable minerals which have been produced from them. Millions of dollars worth of fire clay have been and are being mined from filled sinks in an area in east-central Missouri, east of Highway 63 between the Missouri River and I-44. Towns such as Owensville can be thankful to filled sinks for an appreciable portion of their economy.

Although Missouri's iron production today is from very deep mines, the filled sink deposits have been one of the major sources of iron ore throughout much of the state's earlier history. In some cases sinks were filled with hematite or so-called red or blue ore and in other cases with limonite which is colloquially referred to as brown ore.

A modification of the filled sink is the "circle," from which many tons of lead, zinc, and barite or "tiff" have been produced in the western half of Missouri, south of the Missouri River. The circle differs from the sink in having had a ceiling during the time the original filling material was introduced. The Lake of the Ozarks area has produced many thousands of tons of barite, lead, zinc, and iron ores from filled sinks or circles. In the same area some coal has been produced from filled sinks. Circles are especially famous in southwestern Missouri where they have been a major source of zinc-lead ores, one of the most famous being the Oronogo Circle north of Joplin (No. 233).

The fillings are a nuisance to those drilling water wells because a well encountering such unsound material must be cased through it to prevent caving into the hole. In some cases, the filling material may contain sufficient pyrite or fools gold to be a nuisance as an acid producer. Pyrite is composed of iron sulfide which breaks down to form sulfuric acid. This acid in turn can corrode casing and pumping installations as well as make the water undrinkable.

Filling material may have been a sand which later hardened to a firm sandstone. Consequently erosion may remove the surrounding walls leaving the sandstone as a lone monument to a former filled sink, circle, or cave; such "fossil" cavern fillings are described in this chapter at several localities. The mineral producer loves certain filled sinks, the civil engineer hates filled sinks, especially if they are where he must carry on major construction activities, but the tourist may enjoy them because of the coloration produced by the filling material. Often the sandstones and shales which fill sinks are vari-colored, ranging from brown through red, purple, blue, and green by varying amounts of iron oxide.

Filled sinkholes exposed by highway cuts create engineering problems because the filling material is often rather unsound rock such as clay, shale, poorly cemented sandstone, and fractured, rotten rock of various types. As a result the dangers of rock fall and slumping of the fill material onto the right-of-way are always present. A geologist describing these exposures is tempted to use the term "beautiful" but the temptation is avoided herein and the less contentious term "classic" is probably the more appropriate.

Keller (1979) wrote a facinating account of the mining of diaspore — a superior refractory material — from filled sinks. The diaspore was used for making firebrick to line the boilers of warships during World War II, and most recently, Missouri refractories were used to surface launching pads for the Apollo lunar missions.

226. VICHY ROAD FILLED SINK

Phelps County, at north edge of Rolla, in cut of I-44 at Vichy Road, in NE¼ SW¼ NE¼ sec. 2, T. 37 N., R. 8 W., Rolla 7½-minute Quadrangle.

This exposure is on I-44 at the north edge of Rolla near the Vichy Road overpass, to the west of the Highway 63 overpass. This is probably the most clean-cut and largest exposure along any highway in the state. It is approximately 200 feet wide and about 40 feet in vertical dimension from the road ditch to the first bench. The filling material is predominantly gray shale and sandstone which has slumped and developed a contorted bedding contrasting markedly with the brown dolomite which forms the walls of the sink structure. On the north side, iron oxide produced purple colorations. The filling material is utterly useless but the exposure is such a classic that no geologist would be able to pass it for the first time without a second look and thousands of students have been captive if not captivated viewers. This exposure has been described by Proctor et al. (1972, p. 85-87) and Muilenburg and Beveridge (1954, p. 14-15).

Figure 110 shows two views of the Vichy Road filled sink.

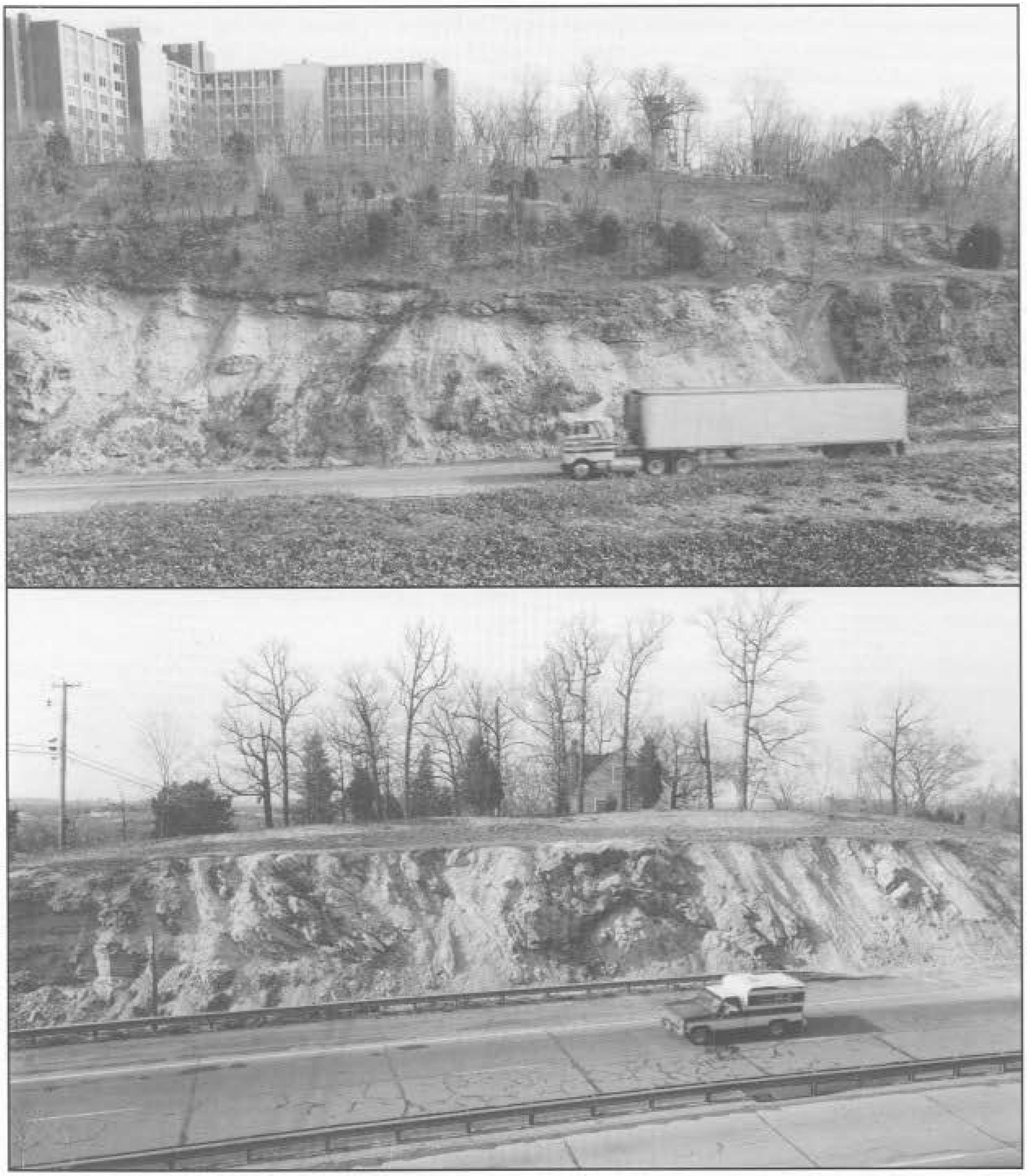


Figure 110

The most convenient filled sink in Missouri is bisected by I-44 on the north edge of Rolla. Vichy Road overpass provides an elevated camera angle. On the north side (top), blocky sandstone slumps into the softer clay, while on the south side (bottom) the laminated and contorted bedding of the clay fill is distinctly visible. Foundation piers for the Thomas Jefferson Residence Hall, visible in the background, also passed through a filled sink. Photos by Jerry D. Vineyard.

227. PACIFIC FILLED SINKS

St. Louis County, along I-44, northeast of Pacific, in secs. 5 and 6, T. 43 N., R. 3 E., Pacific 7½-minute Quadrangle.

The very deep roadcuts along I-44 north of Pacific expose the most troublesome filled fissures in the state. This stretch of difficult highway maintenance extends from 0.7 mile east of Business 44 interchange west of Pacific eastward to 2.1 miles west of Six Flags Over Mid-America. The rock has been extensively fractured in the geologic past and dissolving action of water percolating along the vertical fractures as well as along horizontal bedding planes has created huge fissures which are now filled with weak shales and clay. As a result, the rock is unsound structurally and the constant policing required to remove rock falls assures continuous employment for highway maintenance crews.

A quarry near the west end of this stretch on the north side of the highway further shows the problems created by fissuring of the rock where clay seams and highly weathered limestone along fissures requires cautious and selective quarrying.

228. ASHLAND FILLED SINKS
229. JEFFERSON CITY FILLED SINKS

Portions of Highway 63 in central Missouri also display similar problems of less magnitude because the roadcuts are not as deep. Clay-filled fissured limestones are exposed in cuts south of Ashland in southern Boone County as the highway leaves the upland flat area going south and enters the topographically rough area which flanks the Missouri River bottoms (No. 228). Farther to the south, Highways 63 and 50 going east out of Jefferson City (No. 229) are flanked by cuts, filled fissures, and some filled sinkholes but the cuts are relatively shallow so that maintenance problems have not been unusual.

230. MOUNT STERLING FILLED SINKS

(JDV)

Gasconade County, along Highway 50, east of Mount Sterling, in secs. 11 and 14, T. 43 N., R. 6 W., Goerlisch Ridge 7½-minute Quadrangle.

A lengthy exposure of filled sinks and fissure deposits is conspicuous along Highway 50 in Gasconade County, starting 3.5 miles east of Mount Sterling and extending eastward for a mile through the Cave Hill cuts. These exposures are so variable that no general description can be given. They consist of clay, shale, and sandstone in vertical fissures, along solution openings parallel to bedding of the surrounding bedrock, and a general condition which produced nightmares for civil engineers contemplating deep cuts, tunnels, or foundations in such an environment. Bretz (1950, p. 789-833), in his thorough study of Missouri's filled sink structures, describes the Cave Hill and Otterville (No. 231) sites in detail.

Johnson (1960) reported on Cave Hill Cave, which is a sinkhole-type cave resulting from the reactivation of a once-filled cave. Johnson's block-diagram map shows the cave in graphic detail. Reactivation of the sink apparently occurred as a result of continuing solution of the underlying dolomite by percolating ground water.

231. OTTERVILLE FILLED SINK

Cooper County, 1.5 miles east of Otterville, along Highway 50, in center W½ SW¼ sec. 36, T. 46 N., R. 19 W., Otterville East 7½-minute Quadrangle.

Another filled sink structure, well-publicized in geological circles, is most completely exposed along the north side of Highway C (Old Highway 50), 1.5 miles east of Otterville in Cooper County in a cut between the floodplain of the Lamine River and a roadside park on the south side of the highway. A huge mass of white sandstone, 150 feet long and nearly 30 feet high, is exposed in the cut and the bottom of the sinkhole is marked by the contact of sandstone and bedded dolomite country rock beneath. The white sandstone resembles St. Peter, the same formation exposed at Pacific and Crystal City in eastern Missouri. Because much of the material is sandstone, the filling is more stable than in many of the filled sinks. The area is also of interest because in 1876 the James and Younger brothers held up a passenger train near the present roadside park area.

232. REACTIVATED SINK

Cole County, at west edge of Jefferson City, about 200 yards north of Highway 50 and 0.9 mile northwest of Country Club, in northeast corner NW¼ NE¼ NW¼ sec. 8, T. 44 N., R. 12 W., Lohman 7½-minute Quadrangle.

Geologists commonly look on the filling material of filled sinks with the attitude "Once in Place, Always in Place" (to paraphrase a theological tenet of some). Reactivated Sink didn't stay in place, but collapsed, as the result of a cavity beneath the filled portion. All of the visible collapse activity was within the Jefferson City dolomite.

A news release from the Missouri Department of Natural Resources, Division of Geology and Land Survey, dated March 11, 1975 states in part:

"A large sinkhole surprised folks just west of Jefferson City (Highway 50 and Rainbow Drive) when it appeared suddenly the night of March 21st. Alarmed residents of the area called the county sheriff who cordoned off the hole with a fence, but it kept getting larger and the fence had to be moved several times [see fig. 111].

"The initial collapse swallowed a 30-foot high tree (roots, trunk, limbs and all!) plus tons of soil and rock, creating a hole some 60 feet in diameter and 32 feet deep when first examined by Jerry Vineyard and Ron Ward of the Geological Survey.

"The geologists were not surprised by the event, for numerous such collapses are reported each year. They seem to be more frequent in wet seasons such as the spring of 1973 when about 30 sinkholes were reported to the Geological Survey. Such collapses are unusual for Jefferson City though, and this one happened to be an ancient filled sink that had become reactivated. After some further subsidence around the edges, the new sinkhole probably will stabilize and can be filled with demolition material such as broken pavement, brick, fill dirt and other non-polluting material.

"Though geologists have not yet found a reliable method of predicting when sinkholes are likely to occur, it appears that animals may be able to sense impending collapse in the same way that they can sense when an earthquake is about to occur. Local residents reported that neighborhood dogs were unexplainably disturbed between 10:00 and 10:30 p.m. on Friday night; on Saturday morning the sinkhole was discovered. Maybe they know something that even the geologists don't."

233. ORONOGO CIRCLE

Jasper County, on west edge of Oronogo, in NE¼ SE¼ sec. 36, T. 29 N., R. 33 W., Webb City 7½-minute Quadrangle.

The Oronogo Circle is one of the world's most lucrative filled sinks, having produced more than 30 million dollars worth of lead and zinc ore subsequent to its purchase in 1854 for 50 dollars. This sink is nearly 1,000 feet in diameter and the workings reached to a depth of approximately 190 feet when operations ceased during World War II. One tradition holds that the name Oronogo is derived from a miner's expression "Ore Or No Go." Reportedly this tract was at one time the scene of operations for 20 mining companies. It is now filled with water and was a popular spot for divers; more than five are reported to have drowned in such activities since 1966. Mathews (1974, p. 144-146) summarizes the bonanzas and tragedies associated with the mine.

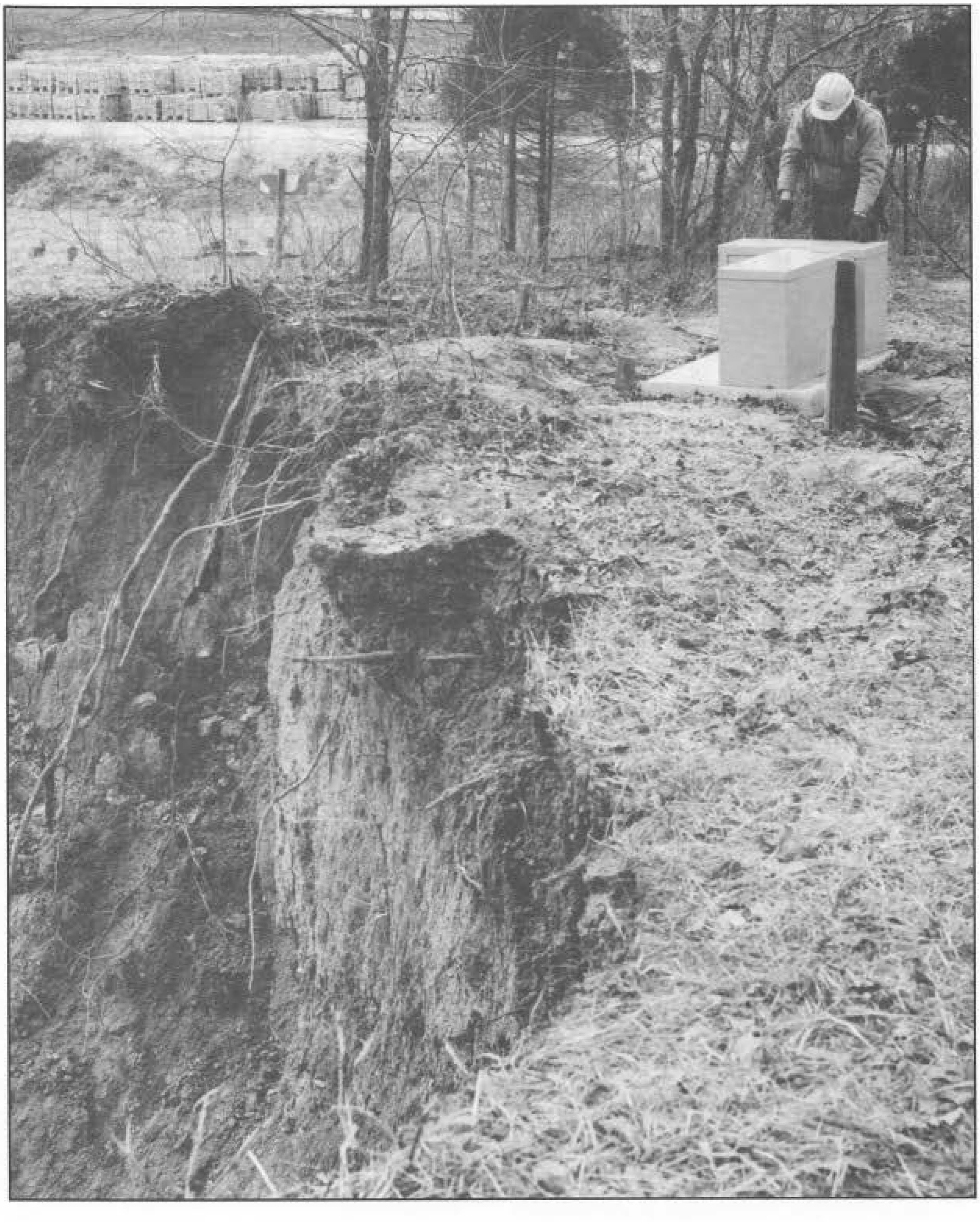


Figure 111

A worker moves a transformer box away from Reactivated Sink at the west edge of Jefferson City. This sink was still collapsing at the time this picture was taken. Photo by Jerry D. Vineyard.

FILLED SINK IRON MINES

234. MARAMEC SPRING MINE

Phelps County, 0.5 mile west of Maramec Spring, in SE¼ SW¼ NW¼ sec. 1, T. 37 N., R. 6 W., Maramec Spring 7½-minute Quadrangle.

The Maramec Pit is one of the most historic in the state and, according to Grawe (1945, p. 423):

> *"Originally it was worked as a source of paint by Shawnee Indians, who showed the iron ore to Thomas James, Jr. of Chillicothe, Ohio on one of their trips east and guided him to the deposit in 1825. On June 14, 1825 James purchased the site of the present mine and spring from the government for $1.25 per acre and then sent for his brother-in-law, Samuel Massey, and a group of workers to build a furnace and open the mine."*

The furnace went into blast in 1829; final operations were in 1878 with an estimated total production of 375,000 tons of ore, mainly hematite. The sinkhole from which the hematite was mined is approximately 250 feet in maximum diameter and 75 feet in maximum depth. This pit is open to the public and featured on an auto trail that includes a miner's cemetery and other features of historic interest. Sufficient hematite remains to be of interest but not enough to be attractive for further mining. Its proximity and relationship to the spring and furnace as well as the presence of a museum makes the area one of esthetic, historical, geological, and (in season) piscatorial interest.

The spelling "Meramec" is used for the river, whereas the official name of the spring is "Maramec."

235. CHERRY VALLEY MINE

Crawford County, 6 miles southeast of Steelville, in W½ SW¼ SE¼ sec. 4, T. 37 N., R. 3 W., Indian Springs 7½-minute Quadrangle.

Grawe (1945, p. 240-253) has given a thorough description of the Cherry Valley Mines. Of the two, Cherry Valley No. 2 was the larger and Grawe describes it as *"...the largest and most productive of all the sink structures in the Ozarks...,"* the pit being 900 feet long, 500 feet wide, and 60 to 150 feet deep. This pit and the smaller Cherry Valley No. 1 pit nearby have had a combined production of nearly a million tons of iron ore valued at almost $2,300,000. The iron sulfide, pyrite, was also produced from the No. 2 pit with a value in excess of $120,000, this material being used for the production of sulfuric acid. The iron ore body is described as a mixture of the iron oxides, hematite and limonite.

Unfortunately, Cherry Valley No. 1 pit has been used as a landfill and is no longer accessible.

SANDSTONE SINK FILLINGS

236. ST. PETER PINNACLE

Warren County, 5 miles northeast of Hermann, on south side of Highway 94, in SE¼ NW¼ SE¼ sec. 22, T. 46 N., R. 4 W., Berger 7½-minute Quadrangle.

St. Peter Pinnacle, so-named herein because it had no previous name, is composed of the St. Peter Sandstone, and is appropriately close to St. Anthony Church. This irregular mound of sandstone is 50 yards in maximum diameter and from 30 to 75 feet tall, containing numerous crevices and several neighboring boulders of the same composition and of impressive size. The unusual shapes of the major mass combined with the many fissures make it an excellent subject for photography and also an intriguing spot for the younger set to climb and explore. It was visited in August when the temperature was 95° F; thus the decision to delegate detailed exploration to a more daring generation, although the temptation is strong to revisit it during the winter and photograph it in the afternoon when the natural light is most opportune.

The large mass appears to be an isolated remnant of a fossil sinkhole filling with the surrounding sink walls of dolomite partly eroded away and the more resistant sandstone filling remaining. Regardless of its genesis, it is attractive and so near the highway from which it is easily visible that it might be considered for development as a public recreation site.

The Pinnacle may be reached by driving east on Highway 94 north of Hermann for slightly over 6 miles to the junction with Highway B and continuing eastward on Highway 14 for 0.15 mile from this junction. At that point, it is obvious on the right-hand side of the road.

237. PINNACLE LAKE PINNACLE

Montgomery County, 4 miles south of High Hill, on Pinnacle Creek, in center N½ NE¼ sec. 24, T. 47 N., R. 5 W., Pinnacle Lake 7½-minute Quadrangle.

The geologic term "inselberg" is of Germanic origin meaning literally "island mountain" and refers to a particular type of isolated land mass. The pinnacle at Pinnacle Lake was originally a distant relative of the inselberg but when the impoundment was made it became a full-fledged insel or island. Fortunately, impoundment enhanced its beauty by setting off its contrast with the countryside as an island rising some 50 feet or more above the surface of the lake, and the submergence of the basal part was more than compensated for by the esthetic results.

This isolated mass of St. Peter Sandstone capped with Joachim Dolomite may have been a remnant of sandstone fill material in an ancient stream channel. The fact that it is approximately

100 feet wide at the base and between 500 and 600 feet long suggests a channel deposit rather than a sinkhole fill. Regardless of its genesis, it need not apologize for its existence and has contributed greatly to making Pinnacle Lake Estates one of the most attractive lake settings in central Missouri.

The lake may be reached by alternate routes: namely Highway Y going east from Highway 19 south of Big Spring and turning north onto Pinnacle Lake Road, or by using the south service road of I-70 between High Hill and the Highway 19 interchange. Pinnacle Lake Road goes south from the service road on I-70 at a point 2.01 miles west of the High Hill interchange, or 2.6 miles east of the Highway 19 interchange. From the service road, drive south for 4.25 miles and then turn right into the development area encountering a locked entrance 0.15 mile from the turn. Despite the locked gates there is an excellent view of the lake at the end of the drive as a welcome interlude from highway driving.

238. MURDER ROCKS

Taney County, 4 miles south of Kirbyville, on west side of Highway JJ, in SW¼ SW¼ SW¼ SE¼ sec. 25, T. 22 N., R. 21 W., Hollister 7½-minute Quadrangle.

Although the Murder Rocks merit recognition as a geologic phenomenon alone, the history associated with them makes them of special interest. They are composed of sandstone containing vertical fractures enlarged by weathering and erosion to form pinnacles 15 feet high and vertical fissures large enough to conceal ambush parties. During Civil War times they were at the edge of the Forsyth, Missouri-Carrollton, Arkansas Road which ran between the Rocks and the present Highway JJ. They have also been given the name Alf Bolin Rocks because the notorious guerrilla of that name used them to ambush civilians and Union troops using the road.

They would make the perfect set for a western ambush scene with rifles peeping from the crevices and the ambushers securely protected and hidden in the maze system of fissures (fig. 112). Mahnkey (1967, p. 19) and Upton (1939, p. 27-29, reprinted) have summarized the activities and demise of Alf Bolin. He was born near Spokane, Missouri in Christian County and during the Civil War led a band of about 20 men who raided an area from Spokane southward into northern Arkansas. Because almost all of the able-bodied men were gone, his more than 20 victims included the very young and very old as well as Union soldiers using the road past the Murder Rocks, especially soldiers travelling alone en route home on furlough.

Bolin was killed by a Union Soldier masquerading as a sick Confederate who used a plow colter (a steel root-cutter from the fore part of a walking plow) to kill him as he attempted to light his pipe from a live coal in the fireplace. His head was cut off with an ax and exhibited on a pole in the town of Ozark, an occasion which reportedly resulted in great rejoicing. McCall (1976, p. 15) has given an excellent summary of the Civil War history of this site.

The Rocks represent an isolated mass of sandstone which probably was an ancient sinkhole or cave fill. The surrounding dolomites were eroded and weathered away leaving this more resistant material.

Special acknowledgement is due Mr. Elmo Ingenthron of Kirbyville, Missouri who acted as a guide to the Rocks and supplied background on the history and geography of the area. The Rocks may be reached via the following route from Highway J south of Kirbyville:

Miles	
0.0	*Junction of Highways J and JJ, 3 miles south of Kirbyville. Go southwest on JJ.*
0.7	*Powerline crosses JJ.*
1.9	*Murder Rocks on northwest (right-hand) side of highway. The few yards intervening between the Rocks and the present highway represent the route of the Civil War road. The Rocks could be photographed in the summer or winter, but minimum foliage would be preferable.*

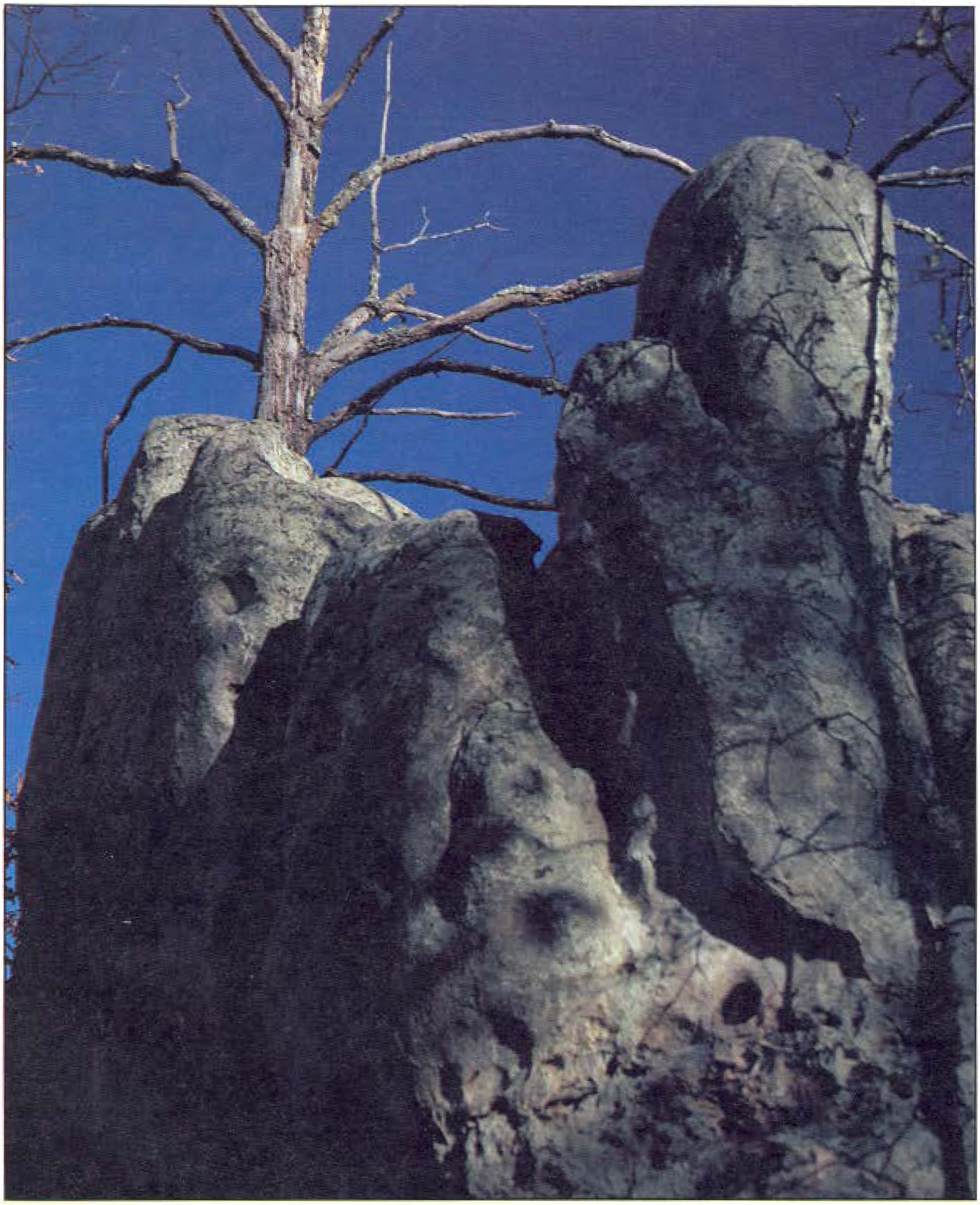


Figure 112

Murder Rocks, an isolated mass of sandstone pinnacles in Taney County, provided a haven for ambush parties during the Civil War. Photo by Jerry D. Vineyard.

239. ROCK HOUSES

Pulaski County, 1.5 miles southeast of Crocker, in NE¼ NE¼ SW¼ NE¼ sec. 21, T. 37 N., R. 12 W., Crocker 7½-minute Quadrangle (Hancock 7½-minute Quadrangle useful to reach site).

The Rock Houses resemble house ruins (fig. 113). Time spent admiring them is more worthwhile than that spent in debating the name, and the walk to them on a cold, damp winter day was well rewarded.

The feature is a mass of sandstone approximately 100 feet in diameter jutting from the northwest slope of a long ridge. The sandstone has been fractured and weathered to form blobs, pinnacles, and slabs standing on end. On the downslope side, the vertical distance from ground level to the crest of the pinnacles is nearly 30 feet. The feature is the most impressive from this downslope side but, unfortunately, is not easily photographed shooting upslope at an angle. Perhaps the ardent photographer might climb a tree to solve this problem?

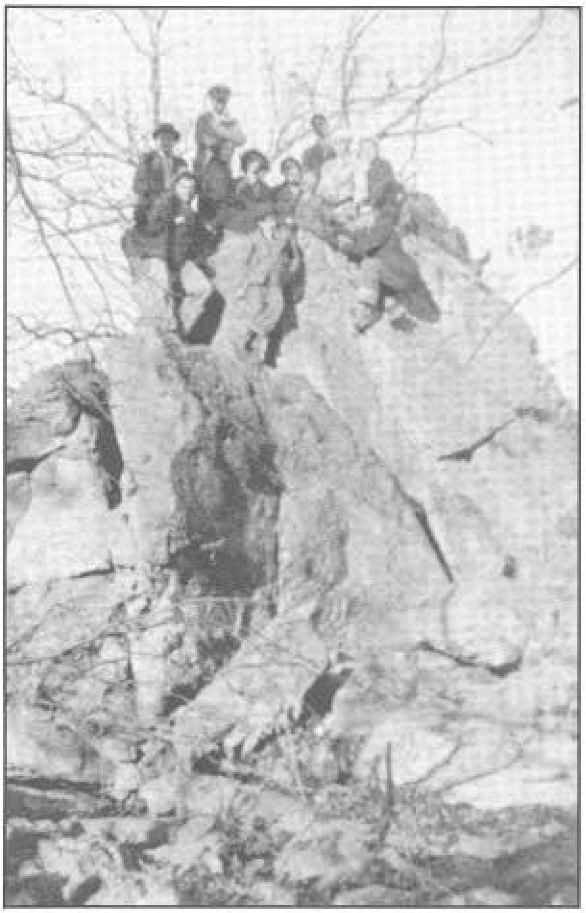


Figure 113

The Rock Houses, a mass of fractured, weathered sandstone, resemble house ruins. Photo by Emma Comfort Dunn (January 1915).

Although the material was originally a sandstone (and some still is), portions of it have been recemented by silica to form exceptionally hard and durable quartzitic sandstone which varies from buff to pink in color depending on the amount of iron oxide it contains as a coloring agent.

The young ones enjoy this exposure because of the climbing opportunities and challenges. The geologist appreciates this exposure because of the well-developed fracture pattern and the unexplained alligator-skin grain of the rock surface. Anyone studying the origin of fossil sinkholes or cave fills should visit the Rock Houses.

The site was reached by the following route:

Miles

0.0	*South edge of Crocker on Highway 17, 0.5 mile north of junction with Highway 133, bear left off Highway 17 onto gravel road that parallels railroad tracks. Follow it across tracks to fork in road.*
0.4	*Bear left at fork and continue southeast.*
1.3	*Turn left at T-junction.*
1.4	*Park at partial stile over fence on left. Climb over stile and follow ridge to the northeast along a conspicuous path to point where highline crosses path. At this point, bear to the left onto a fainter path which trends approximately N 60° W at right angles to the second highline. Follow this path for about 200 yards down the slope to the Rock Houses. The Houses are almost visible at the powerline and are easily spotted in the wintertime as one descends the slope.*

240. STANDING ROCK (CAMDEN COUNTY)

Camden County, 7 miles northwest of Camdenton, in SE¼ SE¼ NE¼ sec. 20, T. 39 N., R. 17 W., Green Bay Terrace 7½-minute Quadrangle.

Camden County has the best identified and best maintained Standing Rock (fig. 114) in Missouri. Fowke (1922, p. 91) describes this exposure under the heading "a fossil cave," postulating a cave which in its lower end "*. . . became solidly filled with sand, . . .*" and states that:

> *"Its surface is an exact cast of the interior of the cave which it filled, and nodules of chert, remaining when the limestone dissolved, are still embedded in its surface."*

His concept of this being an ancient cave filling is reasonable and the fragments of chert included in the sandstone on the west side certainly suggest the contact between the filling material and the postulated cave wall. The exposure is 40 yards long by 15 yards wide and contains fractured pinnacles of sandstone 10 to 15 feet high. The pinnacles are the result of weathering of the sandstone with its nearly vertical fractures. On the surface of some of the sandstone slabs a coarse "alligator skin" or blister pattern is quite marked. Perhaps this represents the mold of the contact between the sandstone and cave clay or wall rock? Regardless of the exact genesis of the sandstone, it is a noteworthy scenic feature and was the namesake to a schoolhouse which stood immediately east of it.

The owners of the Standing Rock Trailer Park appreciate the exposure, have installed a sign pointing to it, and maintain the grounds on the east side of it, so that it is easily accessible as well as attractive.

It was reached by going north from Camdenton for slightly under 10 miles on Highway 5 and turning right onto Lake Road 5-61. Follow this road for 0.25 mile to a fork and take the right-hand fork leading to the Standing Rock Trailer Park. An additional 0.5 mile from the fork one is guided to the spot by a sign on the left-hand side pointing to "The Standing Rock." A trail may be walked or driven for 75 yards to the right to the foundation of the old Standing Rock School with the Rock plainly visible on the right side of the trail. The exposure trends N 20° W and would be best photographed in the morning looking toward the west.

241. STANDING ROCK (DENT COUNTY)

Dent County, 10 miles south of Salem, on Highway 19, in SW¼ NW¼ NE¼ sec. 34, T. 33 N., R. 5 W., Doss 7½-minute Quadrangle.

Standing Rock Creek's namesake is at the bridge over this creek and is included in a small but pleasant roadside park with easy but dangerous access on a blind curve. The mass of rock is a brown sandstone, parts of which are so thoroughly cemented that it is quartzitic. The exposure is about 40 feet in diameter and the crest is some 25 feet above the streambed on the south side.

A stroll both up and down the stream is rewarding because the gravel contains a great many boulders of cryptozoon chert which resemble huge cabbage heads. These particular rocks are believed to represent fragments of the fossil version of an algal reef in the ancient seas.

Standing Rock is on Highway 19, 2.4 miles south of the junction with Highway N and 1.6 miles north of the community of Gladden. In addition to being a picnic area, it is a popular wading site.

242. SLAVE ROCK

Montgomery County, between lanes of I-70, 2.2 miles west of Danville interchange, in NW¼ SW¼ NE¼ NW¼ sec. 27, T. 48 N., R. 6 W., Montgomery City 7½-minute Quadrangle.

Slave Rock is so named because of its history of having been used as a block for auctioning slaves. It is a mass of St. Peter Sandstone, 11 to 20 feet high and 50 feet in diameter protruding conspicuously from the grassy slope between lanes of I-70. Parking is not permitted on the

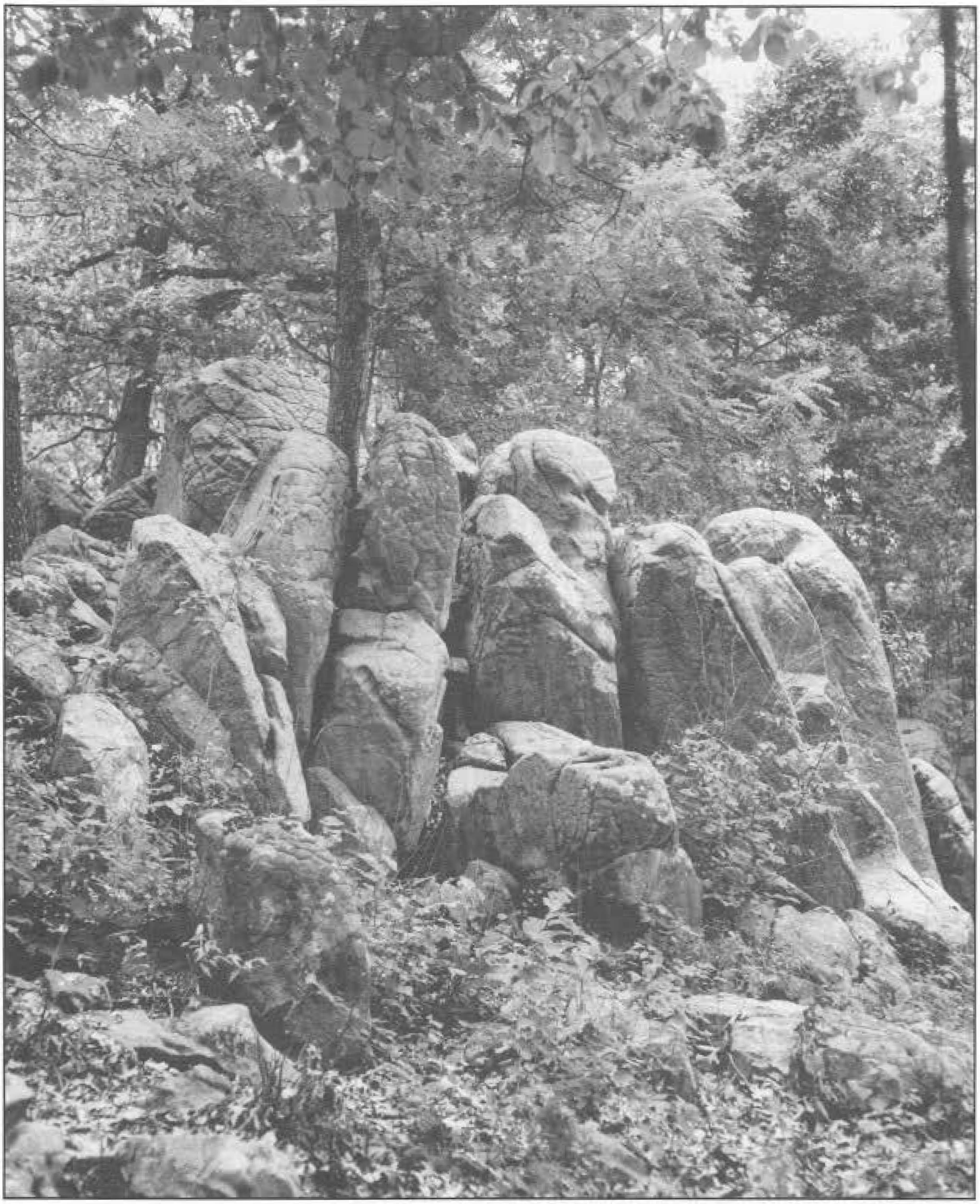


Figure 114

A noteworthy sandstone feature is Standing Rock near Camdenton in Camden County. It is believed to be an ancient cave filling. Photo by Jerry D. Vineyard.

interstate shoulder, so most observers must admire as they drive by at not less than 40 mph and experience a bit of nostalgia for picnickers on old Highway 40 who used it as a bucolic respite from nerve-racking driving.

The St. Peter Sandstone crops out over a fairly large area; Graham Cave in the St. Peter is only 0.25 mile north of this site. Was Slave Rock a fossil sinkhole fill or is it an especially resistant remnant of the main sandstone mass?

243. BIG ROCK (MONITEAU COUNTY)

Moniteau County, 6 miles northeast of California, on north side of Highway N, in NE¼ NE¼ SW¼ NW¼ sec. 5, T. 45 N., R. 14 W., Centertown NW 7½-minute Quadrangle.

Big Rock is modest in dimensions but well known and popular locally as demonstrated by the initials of visitors. It is from 10 to 20 feet high and 60 feet in maximum dimension with the irregular surface typical of such sandstone fossil sink fills.

It is most easily found by starting at the junction of Highways 87 and N, north of California. From this junction, drive east on N for 1.85 miles to a gate on the north (left) side of the highway. Because the ground was soft, the site was reached by following the ridge north from this gate and then northwest a total distance of about 0.3 mile. To the west of the gate is a quarter section fenceline going north. The rock is a few yards west of this fenceline where it crosses the ridge. The mass of rock has supplied the name "Big Rock Forty" to the 40-acre tract in which it lies.

244. BIG ROCK (MADISON COUNTY)

Madison County, 2.25 miles east of Allbright, in NE¼ NE¼ sec. 32, T. 31 N., R. 8 E., Allbright 7½-minute Quadrangle, on which it is named.

The Allbright Quadrangle is the location source for this feature, which was not visited. It is part of a complex and rugged ridge system that rises to over 700 feet from about 480 feet, along the Castor River a mile to the north. The nearest road is over a mile away to the southeast, but a jeep trail passes about a half-mile south of the hill. The green-overprint edition of the map shows continuous forest cover around Big Rock, the only cleared land being along the stream.

The map shows another intriguing feature, Red Sea Hollow, 1.5 miles north-northwest of Big Rock, on the north side of Castor River. The map shows no unusual topography in the hollow. Whence came the name?

245. CASTLE ROCK

Cole County, on east side of road, in NW¼ NW¼ SW¼ SE¼ sec. 8, T. 43 N., R. 11 W., 1 mile southeast of Wardsville, Wardsville 7½-minute Quadrangle.

Cole County's Castle Rock is the namesake for a community in Osage County on the south side of the Osage River. According to Campbell (1874, p. 142) the community had one grist mill and one store in 1874. This community, in the floodplain of the Osage River, was connected with Jefferson City by the Bodie Ferry as indicated on the old Meta 15-minute Quadrangle. There was once a Castle Rock School, on the south side of the river, 2 miles southeast of the community and ferry location.

The mass of sandstone which forms Castle Rock is approximately 25 feet high and is 100 feet in maximum diameter. A clubhouse once stood on the rock and remains of it are preserved as concrete and anchor installations. According to one local resident, the tragic fire which destroyed the clubhouse was caused by lightning on a cloudless, star-filled night.

Castle Rock would be most advantageously photographed during the winter looking north toward the south side where the maximum amount of rock is exposed. It merits an esthetic rating no higher than average but certainly has established itself as a historic landmark. South of the Rock, the road to the former ferry landing passes a recently constructed lake, and during the winter a similar mass of sandstone can be seen by looking west across the lake and a short distance south of the powerline crossing high on the valley wall. To reach Castle Rock from Wardsville, go east from the junction of Highways B and M for 0.85 mile and then turn south (right) off M for 0.4 mile where Castle Rock is exposed on the east side of the road back of a small shed.

246. THETA ROCK

Osage County, 2.5 miles northeast of Rich Fountain, on northeast side of road, in SW¼ NW¼ SE¼ SW¼ sec. 5, T. 42 N., R. 8 W., Linn 7½-minute Quadrangle.

This mass of white sandstone in the northeast bluff of the abandoned loop of the Gasconade is conspicuous from a considerable distance. When the site was first visited, it was goat-festooned, producing thoughts of Heidi and edelweiss.

It is some 50 feet high by 150 feet wide plus additional width at its broad base. The steep face has two shallow caves 6 feet in diameter plus a smaller cave about 3 feet in diameter. This smaller cave has a circular opening crossed by a natural horizontal bar of sandstone which gives it the appearance of the letter Theta in the upper case Greek alphabet.

The age and origin of this sandstone needs further study. Is it a major sink fill? Is it a channel? Is the sandstone Pennsylvanian or is it older?

Regardless of its origin, it is scenic and a valuable member of the team of scenic sites in the area. It may be reached from the junction of Highways 89 and E, east of Rich Fountain via the following route:

Miles

0.0 *Junction of Highways 89 and E. Go north on 89. Deep cut is through rock neck of old loop of the Gasconade which the river breached at the bridge site. After going through cut, road crosses abandoned valley.*

0.5 *Turn left (west) onto gravel road and continue northwest along north edge of abandoned valley.*

2.1 *T-junction, continue straight ahead.*

2.4 *Theta Rock.*

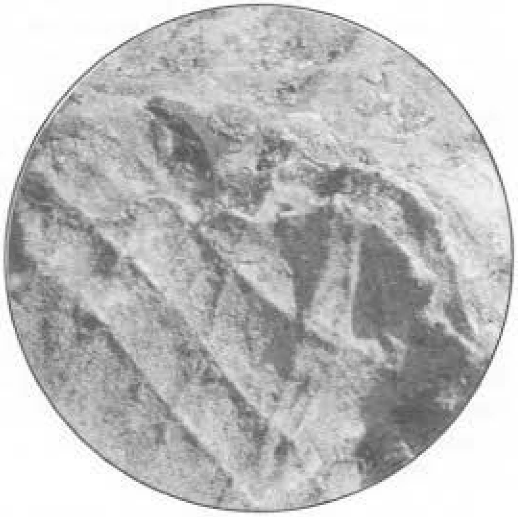
247. BLOSSOM ROCK

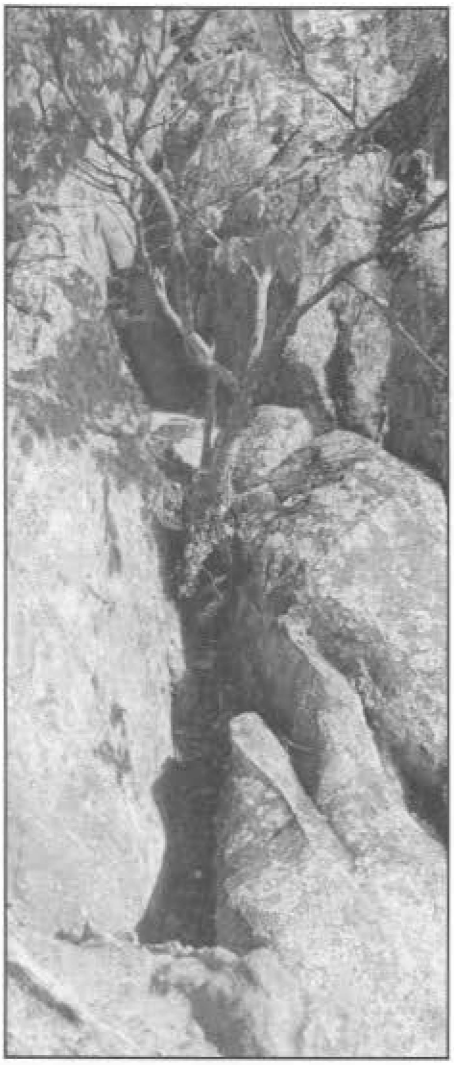
Phelps County, 12 miles south of Rolla in Lane Spring Camp and Picnic Grounds, Mark Twain National Forest, in NE¼ SE¼ sec. 32, T. 36 N., R. 8 W., Yancy Mills 7½-minute Quadrangle (see fig. 115).

Lee (1913, p. 46-49) cites local usage of the term "Blossom Rocks" to describe large masses of sandstone jutting above the surrounding terrain. He considers the sandstone to have been deposited in caves, and the dolomite walls (generally the Gasconade Dolomite) to have been dissolved, leaving the resistant filling material as a conspicuous "blossom." Whether the environment was that of a cave or a sinkhole can be debated but the exposures which are roughly circular in plan view suggest sinkhole fillings.

Fortunately, one of the impressive masses is in the Lane Spring public use area and easily reached via the Blossom Rock Trail. Blossom Rock is an appropriate name because the sandstone appears to blossom out of the underlying dolomite and to need only a few days of warm weather to expand from vertical prismatic buds into a huge flower. The mass is elliptical in plan view with a maximum diameter of 125 feet and averages 15 to 30 feet in height above the surrounding slope with a maximum vertical distance of over 50 feet from the downslope side to the highest pinnacle. The sandstone mass is cut by nearly vertical fractures with the main trend to the northeast. The prisms formed by fractures have been cemented by secondary deposition of silica to produce a very resistant rock.

Photographers should make their visitation when vegetation is at a minimum, but regardless of the season the spot is attractive for climbing and simulating Wild West ambushes.





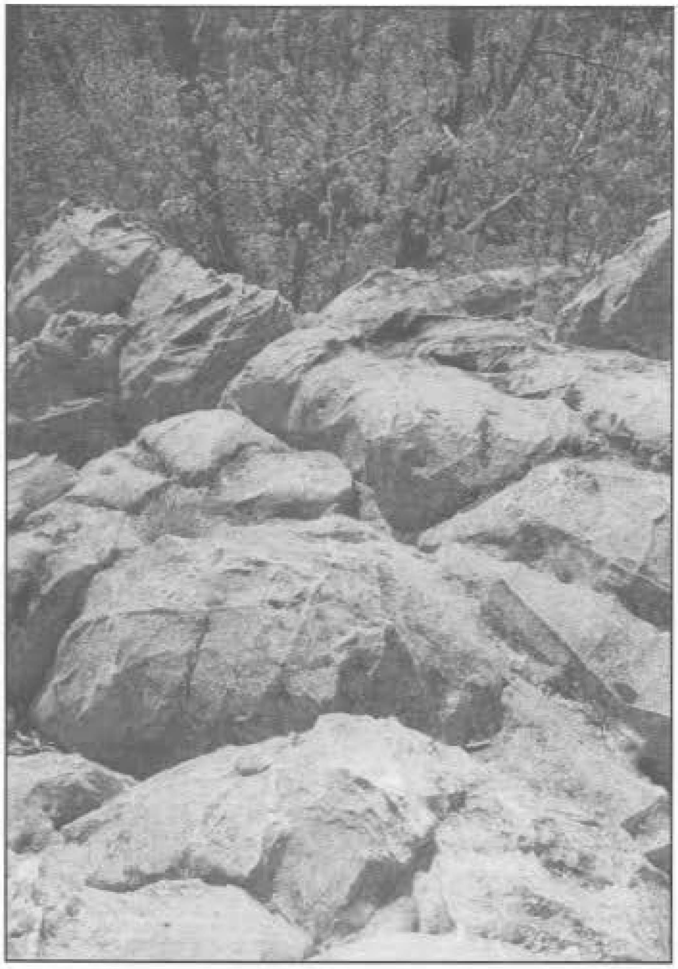


Figure 115

Blossom Rock in the Lane Spring public use area was so named because the sandstone appears to "blossom" out of the underlying dolomite. "Ridgy" texture is caused by mineral-filled fracture lines that are slightly more resistant to weathering than the sandstone matrix. Lizards and lichens love these barren rocks. Photos by Jerry D. Vineyard.

The site was reached via the following route:

Miles

0.0 Drive south on Highway 63 from Highway W junction at Vida, 6 miles south of Rolla.

2.8 Opposite Pilot Knob (elevation 1,239 feet above sea level), one of the most conspicuous erosional remnants in the county which is easily seen from the Rolla area and farther north. Even though it is exceptionally conspicuous it is not the highest point in Phelps County, for that honor goes to Blue Knob in the extreme southeastern part of the county (NW¼ SE¼ sec. 36, T. 36 N., R. 6 W.) with an elevation of 1,288 feet above sea level.

4.4 Turn right off Highway 63 into Mark Twain National Forest camp and picnic grounds (Lane Spring).

5.7 Turn left at picnic area.

5.8 Stop sign at camping area; continue straight ahead.

6.0 Blossom Rock Trail junction at left. Park car and walk Blossom Rock Trail for about 0.4 mile over two bridges and up long slope to Blossom Rock which is on the left-hand side about halfway up the slope.

Other exposures described by Lee (1913, p. 46-49) are cited below because his report is long out-of-print:

"Peter Hollow Exposure. — This mass occurs at the point of a hill about 50 feet below the Gasconade-Roubidoux contact just east of the center of sec. 30, T. 36 N., R. 8 W. The exposure is 55 feet thick, about 100 feet long, and 70 feet wide and is slightly wedge-shaped, the outline, however, not being sharply marked. The material of which it is composed is similar to that of the Yancy Mills exposure but the mass is distinctly bedded. A gentle syncline and anticline are noticeable in the exposed face which are thought to have resulted from the slight folding in the enclosing beds which dip away from the exposure on both sides. The mass is marked by the silicious cracks which have already been described.

"Vessie Exposure. — This mass is found on the north side of a narrow ridge in the S. E. 1/4 N. E. 1/4 sec. 18, T. 36 N., R. 8 W. The mass extends from a few feet above the drain in the upper part of the Gasconade to the top of the ridge almost to the elevation of the second sandstone member. On the south side of the ridge, not more than 200 feet distant, the Gasconade and Roubidoux beds appear in place and the deposit is practically enclosed on three sides and open only toward the drain. The thickness is about 70 feet and the width about 100 feet.

"The material of which this deposit is composed is similar to that at Yancy Mills but here there is very little chert. There is no bedding or lamination. The quartzite seams, though present, are not conspicuous and the joints are without system.

"Kaintuck Hollow Exposure. — This mass occurs on the lower slope of a ridge at the horizon of the lower sandstone of the Roubidoux in the southwest corner of sec. 9, T. 36 N., R. 9 W. The exposure is small and only 30 to 40 feet in diameter and 25 feet high. It is similar in every respect, save size, to the Yancy Mills exposure.

"Rolla Exposure. — On the slope of the divide in the southwest corner of sec. 11, T. 37 N., R. 8 W., lies a mass of sandstone similar to those already described. It lies in the beds just above the pitted member of the Jefferson City and, although not a large deposit, exhibits the usual phenomena of irregular ragged masses of nonbedded sandstone. The deposit lies below and not far distant from a fire clay pit."

248. DEVILS PUNCH BOWL

Phelps County, 10 miles southwest of Rolla, in west-central part of NE¼ NE¼ sec. 36, T. 36 N., R. 9 W., Yancy Mills 7½-minute Quadrangle.

Lee (1913, p. 48) lists this exposure under the heading "Blossom Rocks" in his Rolla Quadrangle report (see No. 247) and describes it as follows:

"Corn Creek Exposure. — This outcrop has been called the 'Devil's Punchbowl' from its basin-like form. It is situated on the upper slope of a hill, well below the contact of the Gasconade and Roubidoux formations in the N. E.

corner of sec. 36, T. 36 N., R. 9 W. The exposure, 100 feet by 125 feet, is roughly circular with the long extension on the slope. It has the form of a rough, truncated cone but is higher on the hill side than on that of the drain. The total height is 40 feet. It is markedly laminated, though not strikingly split into beds. The laminae dip sharply toward the center with an average angle of 25 degrees. The dip is probably due to secondary solution beneath the mass and settling. This is also held to be the cause of the cracks which are conspicuous about the edges. The network of quartzitic seams occurs only to a distance of about 20 feet from the rim of the mass and gives the outer part much greater resistance to weathering than the interior. The inside, in consequence, has been scoured out accentuatuating the basin-like form given by the tilted laminae. The joints are roughly radial and parallel to the edge of the exposure. The grains are well sorted and contain a number of sheets of coarse sand with which are associated bands of angular chert particles about one-eighth of an inch in diameter."

249. CONTORTED SANDSTONE

Texas and Phelps Counties, on Highway 63 north of Licking, in T. 33 and 34 N., along line between R. 8 and 9 W., Maples 7½-minute Quadrangle.

A phenomenon not uncommon in karst areas is the dissolving of soluble limestones and dolomites leaving a residuum of relatively insoluble chert, sandstone, and clay. The results of such activity are well exposed along U.S. Highway 63 beginning approximately 3 miles north of the Highway 32 junction at Licking and continuing northward for a short distance into Phelps County. The Roubidoux Formation consists of interbedded dolomites, sandstones, and cherts with clay and shale. In these exposures reddish-brown sandstone, cherts, and clays have been distorted as they were let down through the dissolving action of percolating waters which removed the dolomite.

The contortions, consisting of sharp folds and deep dips, are probably a result of squeezing as the material contracted, slumping with perhaps some lateral movement, and probably some draping of the insoluble material over pinnacles of dolomite remaining below. Those unfamiliar with the area might be tempted to blame this folding on some dramatic mountain-building force, whereas in actuality the major active force in creating these structures was gravity.

Of the intermittent exposures in the area, the best are 0.9 mile north of the junction of Highway CC where it goes west from Highway 63 and 0.3 mile south of this same junction. A camera is certainly in order and because the road runs due north/south, the best time for photography probably is at noon or slightly before because the better exposures in general are on the west side.

Because of the tendency of this fractured sandstone, which is interbedded with weak clay, to slide as a result of its highly erratic dips, the area has been a headache to highway maintenance men who must periodically remove slump materials from the road ditch.

RESIDUUM

250. DONIPHAN RESIDUUM

Ripley County, on Highway 142, 1 mile southwest of junction with Highway 160, in N½ NW¼ sec. 33, T. 23 N., R. 2 E., Doniphan South 7½-minute Quadrangle.

The Doniphan residuum exposure consists of approximately 60 feet of sandstone, clay, and chert. It does not show the strong crenulations developed in exposure No. 249 on Highway 63 in northern Texas County, but does show some fairly steep dips near the southwest end of the cut. The relatively insoluble material, left as dolomite of the Roubidoux and upper Gasconade formations was dissolved by percolating ground water.

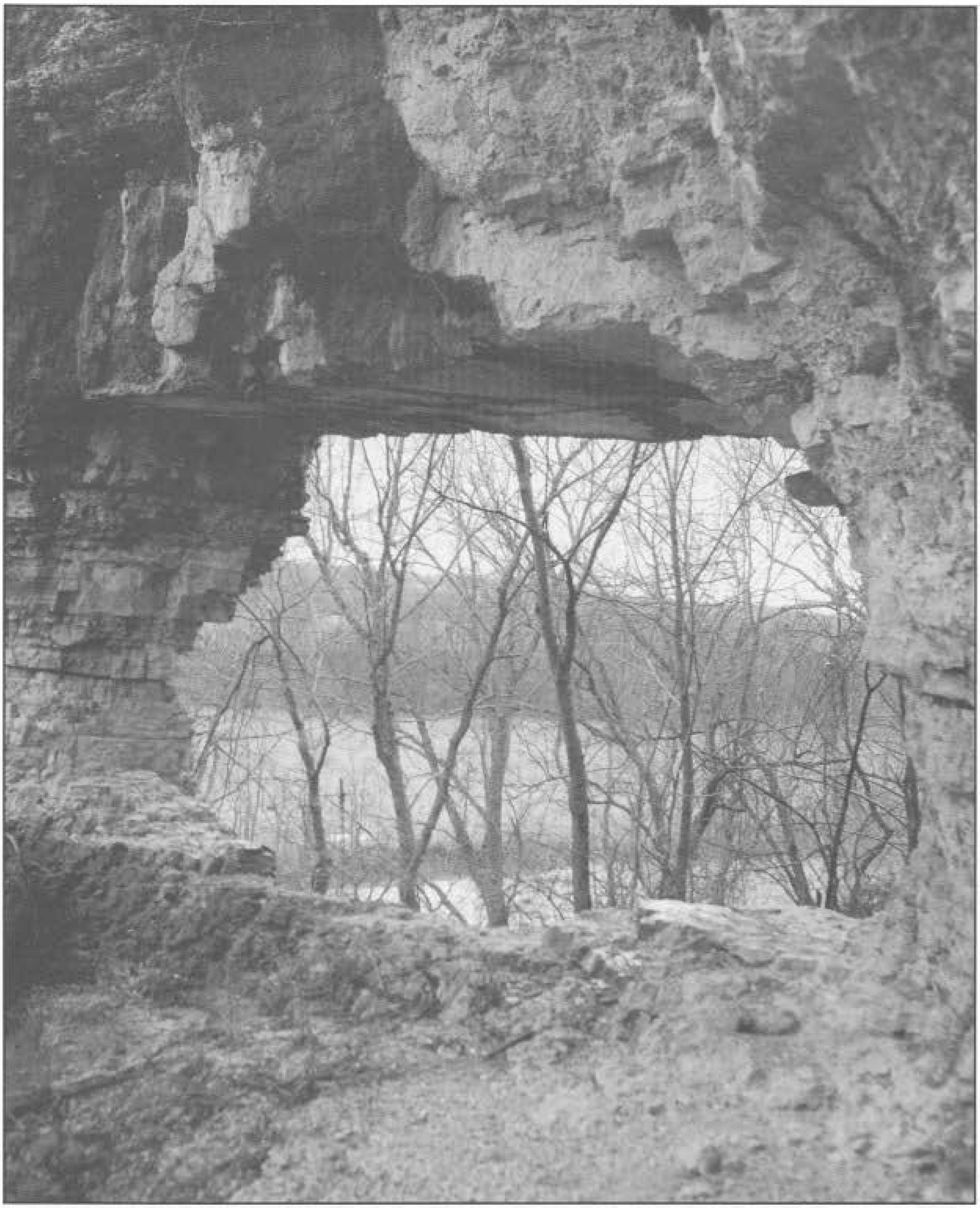


Figure 116

Missouri boasts more than 85 natural arches, bridges, and tunnels. Needles Eye Natural Arch is in a bluff of the Gasconade River in Wright County. Photo by Jerry D. Vineyard.

10

Natural Arches, Bridges, and Tunnels

More than 85 natural arches, bridges, and tunnels are cataloged in this report. The list is undoubtedly incomplete because of lack of information in remote areas. Nearly all of these features in Missouri are karst in origin, prominent exceptions being the sandstone natural bridge near Chimney Rocks (No. 347) in Ste. Genevieve County, Marmaton Natural Arch in Vernon County (No. 276), and the pseudokarst features of Prairie Hollow Canyon near Eminence (No. 80).

Cataloging these features is further complicated by the many such openings too small to merit citation. Examples of this type of feature are at the bluff at the end of the first footbridge below Alley Spring. This bluff is perforated with small arches from the bridge downstream. Big Spring in Carter County also contains a cave with a double entry forming a U-shaped arch above the spring outlet, a phenomenon quite common in spring systems. The Pinnacles, north of Columbia (No. 165), contains several perforations that could be considered natural arches if count competition becomes heated. A county-by-county search would also contribute to keeping Missouri in the running!

Originally an attempt was made to categorize all of these features by origin. This was a failure because many of the features are composite, containing evidence of a combination of karst origins. The major types of karst natural arches, natural bridges, and natural tunnels are discussed separately, however.

LATERAL PIRACY

Clifty Hollow Natural Bridge (No. 278) exemplifies this origin very clearly. In the case of it and its relatives, a stream found an opening through a ridge, probably a small cave or fissure, and took a shortcut into the main stream. The opening was enlarged to perforate the ridge and leave an impressive natural bridge (fig. 117).

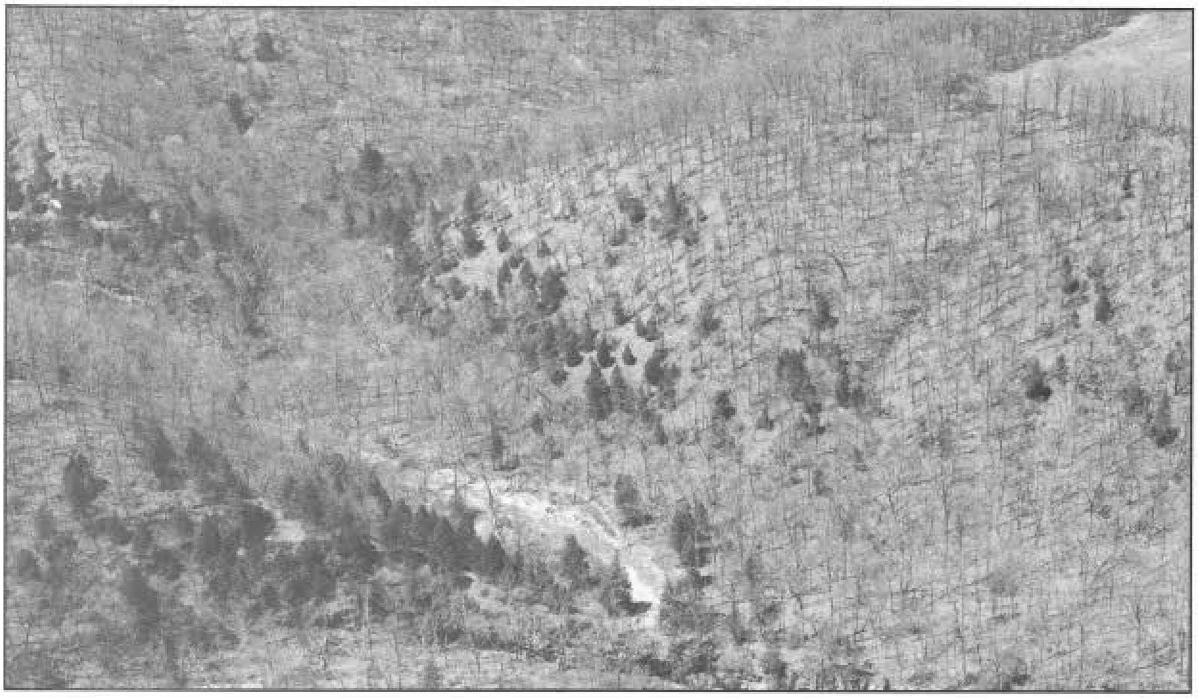


Figure 117

Clifty Hollow Natural Bridge near Dixon is a good example of "lateral piracy" (a stream finds a small cave or opening through a ridge and takes a shortcut into the main stream). Photo by Jerry D. Vineyard and James H. Williams.

SUBTERRANEAN PIRACY

This phenomenon has been mentioned in the discussion of stream piracy and a diagrammatic example is shown in figure 86. Jam Up Natural Tunnel (No. 311) is a classic example of such piracy. This category covers cases where a stream went underground, perhaps into a sinkhole, and followed a cave passage to its mouth. In many cases, the sinkhole and passage were enlarged to some extent and the enlarged cavity became a natural arch, bridge, or tunnel. A very small-scale version of this same phenomenon is sketched on figure 118 and exemplified at Steelville Natural Arch (No. 283), Irondale Natural Bridge (No. 281), and Blackbeard's Cache Natural Bridge (No. 280).

ROOF REMNANTS OF COLLAPSED CAVE SYSTEMS

This category is such a close relative to the subterranean policy that in some cases the two cannot be differentiated. Kassel Cave (No. 341), Ratcliff Cave (No. 342), Grand Gulf (No. 338), Hahatonka Natural Bridge (No. 339), and Rock Bridge (No. 289) are all excellent examples of such roof remnants.

SLICE ARCHES

Such arches or bridges commonly penetrate a wall of rock parallel to the bluff line. This wall of rock characteristically owes its existence to a fracture system which may have determined the bluff line and which also isolated the slice parallel to the bluff line by enlargement of the fracture fissure. Hootentown Arch (No. 266) is a classic example of such an arch and many of these small natural arches fall into this category. An exception to the usual geometric relationship is at the Needles Eye (No. 267) where the arch is at right angles to the bluff line, suggesting that a set of fractures perpendicular to the bluff controlled the orientation of the arch.

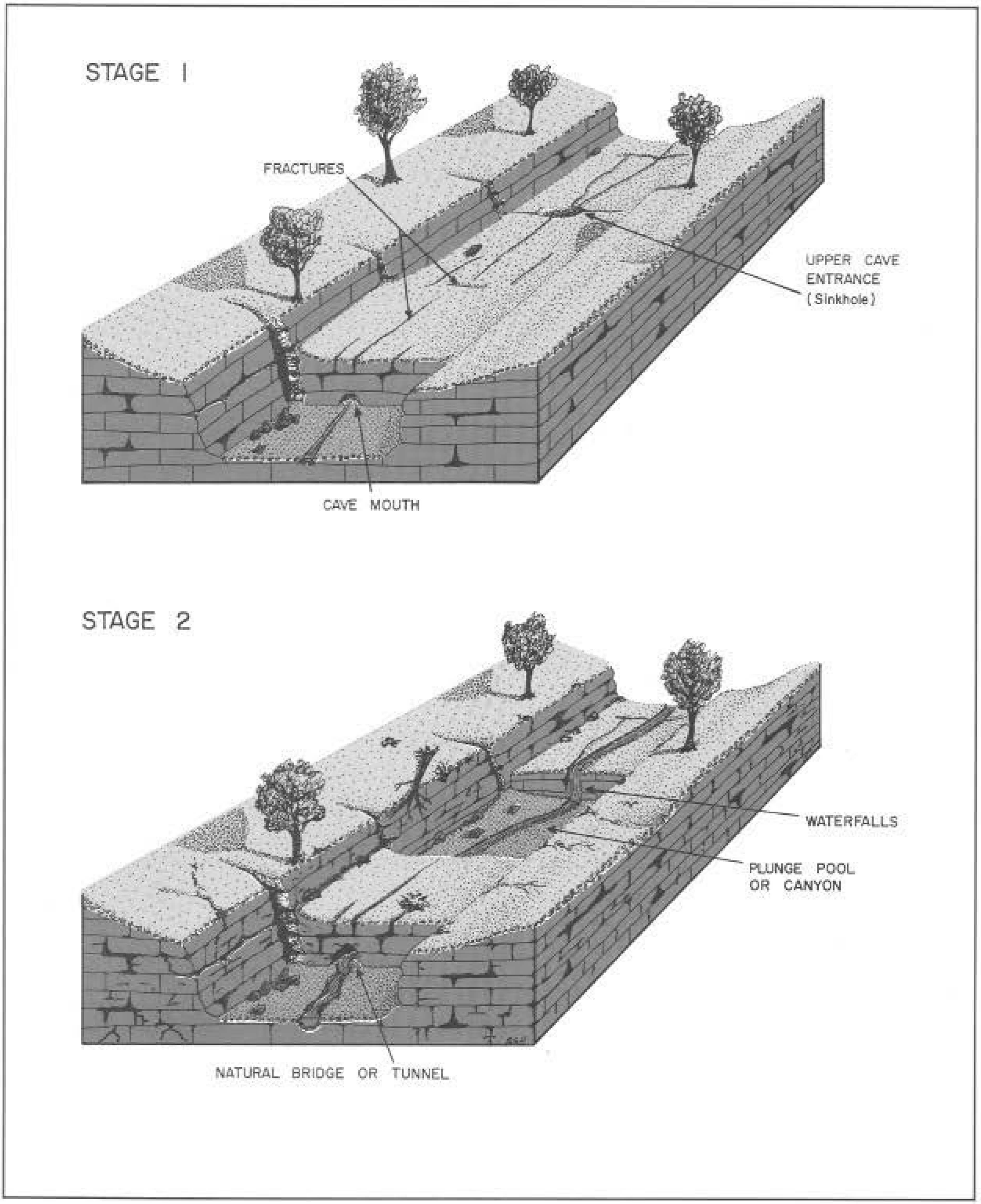

STAGE 1
FRACTURES
UPPER CAVE ENTRANCE (Sinkhole)
CAVE MOUTH
STAGE 2
WATERFALLS
PLUNGE POOL OR CANYON
NATURAL BRIDGE OR TUNNEL

Figure 118

Steps in the development of natural bridges, canyons, and falls systems. Stage 1 (top) shows development of a cave system while stage 2 (bottom) illustrates creation of a natural bridge or tunnel. Drawing by Billy G. Ross.

NATURAL ARCHES

251. PROTO ARCH

Phelps County, 5 miles southwest of Newburg, in SW¼ SE¼ NW¼ SW¼ NW¼ sec. 22, T. 36 N., R. 9 W., Kaintuck Hollow 7½-minute Quadrangle.

Proto Arch is formed in Roubidoux Sandstone that rims a ravine. It is so named because it represents a very early stage in the formation of natural arches. Northwest-trending vertical fractures which cross the sandstone at right angles to the ravine bed have slotted an overhang to produce an arch 4 feet wide with an 8 to 10 foot span and a ceiling height of only 2 to 3 feet. This arch is not particularly appealing to the photographer, but is mentioned herein as a good example of an early stage in the formation of natural arches and bridges. It could be enhanced slightly by clearing some of the sandstone debris from beneath it. Directions for reaching the arch are included under No. 305, Kaintuck Hollow Natural Tunnel, which is nearby.

252. BUTTRESS ARCH

Shannon County, 4 miles north-northwest of Montier, along Jacks Fork, in SW¼ NW¼ NW¼ sec. 4, T. 27 N., R. 6 W., Jam Up Cave 7½-minute Quadrangle.

Buttress Arch, a sliver of bluff along the Jacks Fork, appears to be supporting the dolomite bluff as a "flying buttress" would. It is about 10 feet long and high enough to walk through. Information supplied by Mr. Scott House.

253. NATURAL BRIDGE CAVE

Crawford County, on Meramec River, about 0.75 mile downstream from Idlewild Lodge, in NW¼ NW¼ NW¼ sec. 20, T. 38 N., R. 4 W., Cuba 7½-minute Quadrangle.

Mr. Richard Orr reports a small cave that has a natural bridge separating an upper and lower entrance. The cave and rock span can be seen from the Meramec River, but they are seldom visited because from river level they do not appear attractive.

254. PINE TREE NATURAL ARCH (JDV)

Texas County, 5 miles northwest of Mountain View, near base of south bluff of Jacks Fork, in SE¼ NE¼ SW¼ NE¼ sec. 28, T. 28 N., R. 7 W., Pine Crest 7½-minute Quadrangle.

Pine Tree Natural Arch is near the base of the southwest bluff of Jacks Fork, in the Roubidoux Formation. It is relatively small and deserves recognition by the floater, but might be a bit disappointing to those afoot on a hot summer day. The floater can be alerted to its location by a conspicuous pine tree a few feet upstream from it and should note that it is a short distance downstream from Chimney Rock (No. 346).

255. JACKS FORK NATURAL ARCH

Shannon County, approximately 2 miles northwest of Jam Up Natural Tunnel, in bluff on east side of Jacks Fork, near center NW¼ NW¼ sec. 4, T. 27 N., R. 6 W., Jam Up Cave 7½-minute Quadrangle.

David Butherus, graduate student in geology at UMR, supplied information on this site. The arch is near the south end of and about halfway up a steep bluff on the east side of where Jacks Fork flows south, downstream from Daveys Hollow.

The arch penetrates a rock slice paralleling the bluff line and separated from it by a north-trending fissure. The fissure has sliced a cave entrance to isolate the arch from its parent cavern.

According to the topographic maps, the arch is most easily reached by river. A land approach would probably involve a combination of difficult driving followed by hiking.

256. HENLEY NATURAL ARCH

Cole County, 1.5 miles east of Henley, in north bluff of Osage River, NW¼ SW¼ SE¼ sec. 31, T. 42 N., R. 12 W., St. Elizabeth 7½-minute Quadrangle.

Henley Natural Arch is easily accessible, and visitation is recommended not only because of the short walk to it, but also for the excellent view of the Osage Valley en route. The arch has a 20-foot ceiling, 20-foot span, and a passageway about 50 feet long which trends southeast, terminating in the upper part of the bluff overlooking the Osage. It has been improved by construction of retaining walls and stone steps down the steep passageway.

All of the arch is in the Gasconade Dolomite and it represents another example of subterranean piracy as the short ravine draining into it took a steeply inclined shortcut through the upper part of the bluff in its plunging descent to the Osage.

The simplest route for those not familiar with the area is as follows:

Miles	
0.0	*Junction of Highways BB and H, south of Spring Valley Baptist Church, a mile north of Henley. Take gravel road going southeast from H opposite the junction with BB.*
0.7	*Y-junction, bear left on main gravel road.*
1.8	*Elaborate entrance to private lane on right; continue on gravel road.*
2.35	*Bear right off gravel road onto parking area. Follow trail on foot from parking area to overlook on top of bluff. After admiring the view, bear left (east) and follow trail along bluff for approximately 50 yards watching for steep foot path to the left leading down into the upper entrance of the arch. Those missing this path will walk directly over the arch and could thus orient themselves, returning to the path on the left side of the upper entrance.*

257. BAT CAVE NATURAL ARCH AND PINNACLE

Miller County, in east bluff of Osage River, 5 miles north of St. Elizabeth, in center E½ NW ¼ NW¼ NE¼ sec. 7, T. 41 N., R. 12 W., St. Elizabeth 7½-minute Quadrangle.

This arch is similar in appearance, setting, and origin to Henley Natural Arch (No. 256) 1.3 miles to the north and is obviously close kin to it — a cousin or even a brother? It was described as Tavern Creek Natural Bridge by Kruesi et al. (1973), but Bat Cave Natural Arch seems a more appropriate name because of its proximity to that well-known cavern and the fact that it is not on Tavern Creek. The arch penetrates a Gasconade Dolomite flange at the northwest end of the bluff containing Bat Cave and is approximately 250 yards northwest of that cave. It has a span of 10 to 15 feet, a ceiling height of approximately 20 feet, and a ceiling thickness of 30 feet. The flange it penetrates is 7 to 8 feet wide and is paralleled by fractures trending almost due east-west. The upslope side of the steep valley penetrating the arch terminates abruptly, suggesting a breached sinkhole.

Because of the steep slopes, the site is not easily photographed. It was not visible from the road during the summer but is reported to be so when the leaves are off. A remnant of this flange a few yards farther to the northwest has formed a pinnacle approximately 30 feet high, 3 to 4 feet wide, and 25 feet in maximum diameter. This pinnacle (fig. 119) also is composed of Gasconade Dolomite, so coarsely crystalline that it superficially resembles a coarse sandstone. It also owes its existence to two vertical fractures which parallel its longer axis and would be a better subject for photography when foliage is at a minimum.

The two features were reached via the following route:

Miles

0.0 *Junction of Highways 52 and E at northwest edge of St. Elizabeth. Go north on Highway E.*

3.5 *End of Highway E; bear left on gravel road going north toward Osage River Public Fishing Access.*

4.9 *Bear right and cross Tavern Creek, bearing left at bluff.*

5.15 *Opposite Bat Cave (Bat Cave is owned by the Missouri Department of Conservation and has been set aside as a Natural Area as habitat for Gray Bats, which are protected under the federal Rare and Endangered Species Act). Those walking will have no problem in locating the cave even in summer because of the characteristic smell resulting from bat occupancy. From the cave, drive to the northwest, watching for the terminus of the bluff (and in wintertime for the arch).*

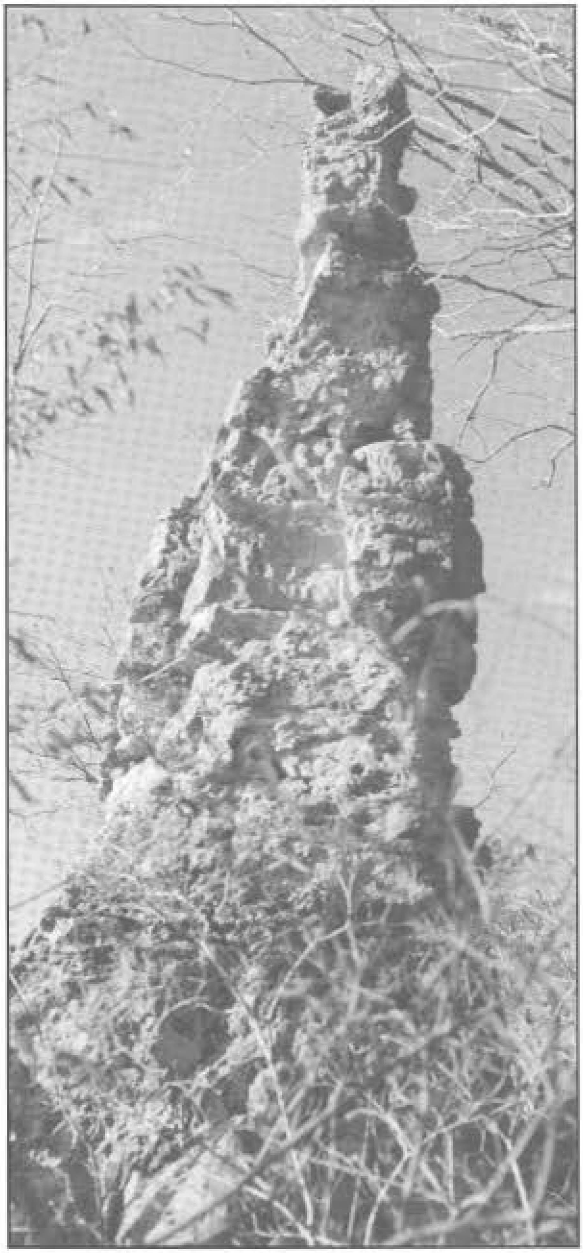


Figure 119

Bat Cave Pinnacle is a 30-foot high remnant of a Gasconade Dolomite flange at the northwest end of the bluff containing Bat Cave. Photo by Jerry D. Vineyard.

258. BODE CAVE NATURAL ARCH

Miller County, 0.5 mile northeast of St. Elizabeth, in tributary ravine to Tavern Creek, in SE¼ NE¼ NW¼ NE¼ sec. 33, T. 41 N., R. 12 W., St. Elizabeth 7½-minute Quadrangle.

Bode Cave has a ceiling 9 feet high at the entrance, is approximately 20 feet wide, and narrows as it is traced inward along an approximate trend of N 60° W. It is reported to have been penetrated approximately 200 yards to a point where the low ceiling makes crawling difficult. The natural arch to the northeast is undoubtedly a remnant of the cave, and the 60 feet of intervening canyon represents an area where the roof has collapsed.

The arch has a span of about 20 feet from wall-to-wall and a width of 30 feet. The maximum ceiling height is 15 feet and the roof is about the same dimension in thickness. A streamlet issues from the cave and after penetrating the arch makes a steep drop and turns to the right to enter the ravine trending into Tavern Creek.

Morning would be the best time to photograph the arch because the downstream side is the more impressive and the best view is looking west of due south. Foliage could be a problem and should be considered in selecting the season for photography.

From the junction of Highways 52 and E at the west edge of St. Elizabeth, drive 0.6 mile east on Highway 52 and park; obtain access permission at the house on the right side. From the house, angle eastward and northward along the major ridge shown on the topographic map near the center of the NW¼ sec. 33, watching for a path on the left which bears northward into the ravine containing the natural arch.

The literature is confusing regarding the identity and location of Bode Cave. Fowke (1922, p. 94) describes it as being 0.5 mile south of St. Elizabeth and having a natural bridge in front of it. Because of an identical name, nearness to St. Elizabeth, and relationship to natural arch and cave, the cave and arch described in the present text are undoubtedly the same as those mentioned by Fowke. Ball and Smith may be referring to the same cave (1903, p. 12) when they describe two caves under one heading of Beckman's Cave as follows:

> *"Two caves occur in the Gasconade limestone in Sec. 28, T. 41 N., R. 12 W. The larger extends a quarter of a mile into the hill. A partial falling in of the roof at the entrance has formed a miniature natural bridge. The stalactites, though small and few in number, have a beautiful white color.*
>
> *"In the smaller cave, stalactites are very numerous. At the present time the waters are rapidly depositing a dark brown, banded travertine on the sides of the chambers. The travertine is in some places 18 inches thick. Mr. Beckman says that within his memory many chambers which were formerly passable, are now almost completely closed due to the travertine."*

Ball and Smith did not have a good topographic map base and the southeast quarter of sec. 28 is within a short distance of Bode Cave. The numerous ravines and the heavy timber cover could account for the discrepancy in locations. Ray Doerhoff of St. Elizabeth graciously acted as a guide (on a 95° day) to this well-known site.

Note: Information received in 1984 indicates that Bode Cave extends far beyond the spot about 200 yards from the entrance mentioned by Beveridge, *"...to a point where the low ceiling makes crawling difficult."*

Wonder—visitor tool kit:
Geologic Wonders book
Camera (with film)
Topographic map(s)
Insect repellant (in season)
Happy smile and friendly greeting

259. RICHBARK NATURAL ARCH

Carter County, east bluff of Current River, northwest edge of Van Buren, in NW¼ NW¼ sec. 24, T. 27 N., R. 1 W., Van Buren North 7½-minute Quadrangle, where it is shown as Richbark Cave.

Mr. James Zollweg reported a natural arch associated with Richbark Cave, but gave no further details.

260. TURNER NATURAL ARCH

Shannon County, 5 miles south of Bunker, on north bluff of Big Creek, SW¼ NW¼ NE¼ SW¼ sec. 18, T. 31 N., R. 2 W., Bunker 7½-minute Quadrangle.

Two fine beaver dams, a Pippa Passes spring day, and easy access, made this a most enjoyable visit. Because the arch is about 100 feet above the creek on a wooded bluff, the most opportune visitation is when the weather is cool and the foliage light. The arch was visible from the road in late March but would be hidden by summer foliage.

The topographic map is the best guide for locating the arch. Park abeam of it on Highway P and walk north, fording the stream a la Little Eva on slippery stepping stones immediately below the lower beaver dam. After crossing the stream, go upstream to the upper beaver dam and then head for the bluff and arch which are at the inverted Y symbol on the Bunker Quadrangle.

The arch in the Gasconade Dolomite has a 50-foot span, a 10-foot ceiling, and a 15-foot thick roof, and is 10 feet wide. It trends east-west, or parallel to the bluff line, but is difficult to photograph because of the steep bluff slope. Above the bluff is Arch Cave with its entrance a few feet higher than the top of the arch.

Huge blocks of dolomite extending from the cave mouth to the arch and down the bluff are remains of a longer cave system, as is the arch (fig. 120). The area between the arch and the cave represents nearly complete destruction of the cave.

The cave has an opening about the same size as the interior of the arch and was probably a welcome shelter to prehistoric man. Modern man can enjoy not only the cave and arch, but also the two beaver dams and the beaver slides (the view, that is) on the north side of the impounded areas.

Directions for reaching the arch are as follows:

Miles

0.0 Turn south off Highway 72 onto Highway P 3 miles southeast of Bunker.

4.7 Park on Highway P. Arch may be seen from highway during proper season. Cross valley as described previously.

NO
TRESPASSING
Per
Landowner's Request

261. SPRING VALLEY NATURAL ARCH

Shannon County, 11 miles north of Eminence or 2 miles southwest of Round Spring, on west side of Highway 19 near west line, NW¼ SE¼ SW¼ SW¼ sec. 30, T. 30 N., R. 4 W., Round Spring 7½-minute Quadrangle.

A prerequisite for driving to this site is good brakes and no fear of (but a healthy respect for) steep hills. Kiddies would love the roller coaster ride en route and the variety of erosional forms associated with the arch.

The arch is in the Eminence Dolomite and is the remaining portion of a cave whose roof collapsed. It is in an east-facing low bluff, has a span of 20 feet, a roof height of 10 to 15 feet, and has a very short time to live — perhaps as little as one or two thousand years. The prognosis of death is based on the fact that the arch, which is 6 feet wide, has a ceiling only a foot thick which has rotted through near the apex.

Back of this arch is an open area representing the collapsed part of a cave a few feet farther back in the bluff. The dimensions of the cave entrance are approximately those of the arch, but the temptation to walk in a greater distance was deterred by the lack of a light. Water flows from the cave into the small open court, then under the arch and down a 12-foot stairstep, cascading into a concrete stock tank. The arch

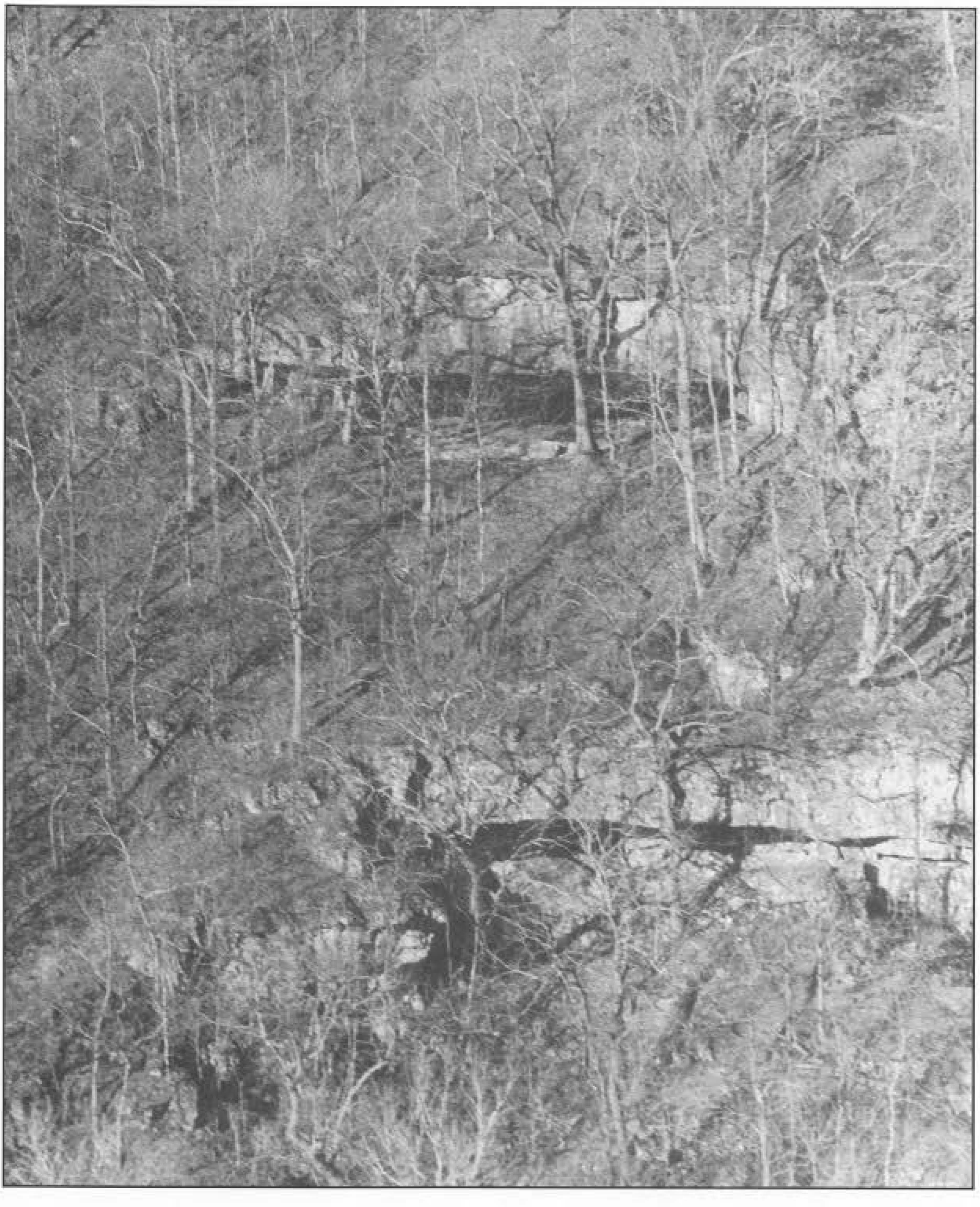


Figure 120

Arch Cave (upper opening) and Turner Natural Arch (lower opening) are remnants of a once-continuous cave system. Photo by Jerry D. Vineyard and James H. Williams.

and the cave contain large solution pockets and, on the north side of the arch, a mini arch offers opportunities for the kiddies to crawl and fall.

The setting is a pleasing one, sylvan, somewhat craggy, and a veritable Elysian bluff for a landscape architect or rock gardener.

The site was reached from Round Spring by going south on Highway 19 for 1.2 miles and turning right (southwest) onto a gravel road. Follow this road for 1.85 miles, being certain to shift gears for steep ascents and descents, and ford two streams on low-water bridges. Park in front of the second house after a low-water bridge and continue on foot for an additional 100 yards on the road (now a trail) you have been following. The bridge is on the right side of the road and most easily reached by descending the bluff on the south side of it and the cave.

Upon returning to Highway 19, make certain you have seen the strip of virgin pine on both sides of the highway, starting about a mile south of the turnoff. Also — don't miss Alley Spring and Round Spring!

262. ROCKHOUSE CAVE ARCH

Shannon County, 2 miles upstream from Pulltite Campground access, in south bluff, in approximately SE¼ NW¼ sec. 34, T. 31 N., R. 5 W., Round Spring 7½-minute Quadrangle.

Hawksley (1972, p. 93) describes this cave as:

> *"A meander of a cave cut off by the deepening river valley, it is now more like a natural bridge than a cave and makes a good shelter."*

The site is 2.3 miles downstream from Cave Spring or 7.5 miles below Akers Ferry.

263. HEIMOS CAVE NATURAL ARCH

St. Louis County, 0.5 mile south of junction of Ringer and Milburn Roads, 1 mile northwest of Oakville, in NE¼ NW¼ NW¼ sec. 11, T. 43 N., R. 6 E., Oakville 7½-minute Quadrangle.

Heimos Cave had an arch in front of the south-facing entrance, but the feature has been obliterated by development.

264. DRY FORK NATURAL ARCH

Phelps County, 3.5 miles southeast of St. James, in south bluff of Dry Fork, in southeast corner sec. 33, T. 38 N., R. 6 W., Maramec Spring 7½-minute Quadrangle.

Dry Fork Arch may not be unusually spectacular, but it is visible from the Missouri Highway 8 and 68 bridge over Dry Fork on the route from St. James to Maramec Spring and certainly merits the minimum salutation of a glance from the car when not obscured by foliage during the winter season. A southbound passenger (or Devil-may-care driver) may see the arch from the center of the Dry Fork Bridge, by looking up and to the right into the bluff on the opposite side of Dry Fork.

The arch is in the Gasconade Dolomite and has been described by Mueller (1951, p. 26-28) as having a span of 15 feet and being 12 feet high and 8 feet wide. He considers it the remnant of a cave which has been almost completely destroyed by erosion.

265. PINNACLES BLUFF AND NATURAL ARCH

Phelps County, 3 miles east of St. James, along gravel road, in north bluff of Dry Fork. Natural arch in center SW¼ SE¼ SW¼ sec. 23, and Baby Pinnacle in SW¼ SW¼ NW¼ NE¼ sec. 26, T. 38 N., R. 6 W., Maramec Spring 7½-minute Quadrangle.

The ideal time to visit this site is when foliage is at a minimum so that the pinnacled bluff and the arch are visible from the road and Baby Pinnacle may be photographed.

The arch is an average photographic subject, best shot in the late afternoon or middle morning when the sun lights its west-trending passage. It penetrates the rib of a pinnacle to form an opening 15 feet long, 7 to 10 feet wide, and 6 to 7 feet high. It was formed along a fissure paralleling the bluff line and its west entrance is visible a few feet above the base of the vertical bluff cresting a steep talus slope.

The log from St. James to the arch and Baby Pinnacle is as follows:

Miles

0.0	*Go east toward Boys Town on Highway DD from its junction with Highway 68 in St. James.*
1.2	*Impressive ledges of Roubidoux sandstone on north bluff of artificial lake to left.*
1.85	*Boys Town. Straight ahead on blacktop which continues as gravel road 0.5 mile ahead.*
3.5	*Natural Arch in pinnacled bluff to left. To right, Dry Fork makes sharp bend and parallels the road.*
3.6	*Steep path on left leads to low shallow cave in bluff. Other openings conspicuous between this cave and the arch.*
3.85	*Baby Pinnacle on right. Parking site a few yards ahead on left. Pinnacle has a pedestal only 2 feet in minimum diameter with a cap more than double that dimension. Best photograph for pedestal-cap contrast is looking northwest.*

The arch and pinnacles are all developed in the Gasconade Dolomite.

266. HOOTENTOWN NATURAL ARCH

Stone County, 20 miles south of Springfield or 6 miles west of Highlandville, in west bluff of James River, in SW¼ NW¼ SW¼ sec. 30, T. 26 N., R. 22 W., Hurley 7½-minute Quadrangle.

Hootentown and Leatherwood (No. 272) arches are the largest Missouri arches west of St. Louis and vie for first place in the state if the description "natural arch" is qualified so they can nose out the man-made arch rival.

Hootentown Natural Arch (fig. 121) is 80 feet high from base to crest, 60 feet from base to ceiling, and has a span of 80 feet. Its width varies from 5 to 20 feet, but in general appearance it is quite slender, thus negating any debate over natural "arch" versus "bridge."

Because it is partly obscured by timber, Hootentown Natural Arch is not easily photographed. Photography would be best from a plane on a winter morning when maximum sunlight is available. An alternative might be shooting westward from the east side of the James River. An oblique aerial shot would have the advantage of showing the relationship of the arch to the bluff. As viewed from above, the arch gives the impression of having been sliced by a giant cleaver with a vertical crevice 1 to 12 feet wide separating it from the bluff. This crevice is obviously a fracture enlarged by weathering, and the common northwest trends of the arch, crevice, and bluff, as well as some nearby stream valleys suggest that all these features were developed along a system of northwest-trending fractures.

The arch contains Mississippian rocks consisting of four formations from base to top: Northview shale, Pierson limestone, and Reeds Spring and Elsey limestone and chert (flint) nodules.

Hootentown Arch has long been popular as a picnic spot and is reportedly a vantage spot for observing James River traffic, especially those who may be straying from the high code of ethics of the True Gigger. Trails lead to both the top and base of the Arch (fig. 122). The base trail is safer and steeper; the two to the crest are less tiring and more scenic, but require a short tether on the very young who wish to cross the top of the narrow arch. The Arch is currently (1976) posted as a result of a fatal fall from it in 1975.

The ideal hike for those who have reached the Age of Reason is to the base of the Arch; thence to the top via the steep slope of the crevice at the northwest edge of the Arch. Should you encounter those who wish to debate the name of the Arch, be noncommittal; the area contains a Hooten Hill, Hooten Cave, and Hootentown Bridge, but no town of Hootentown.

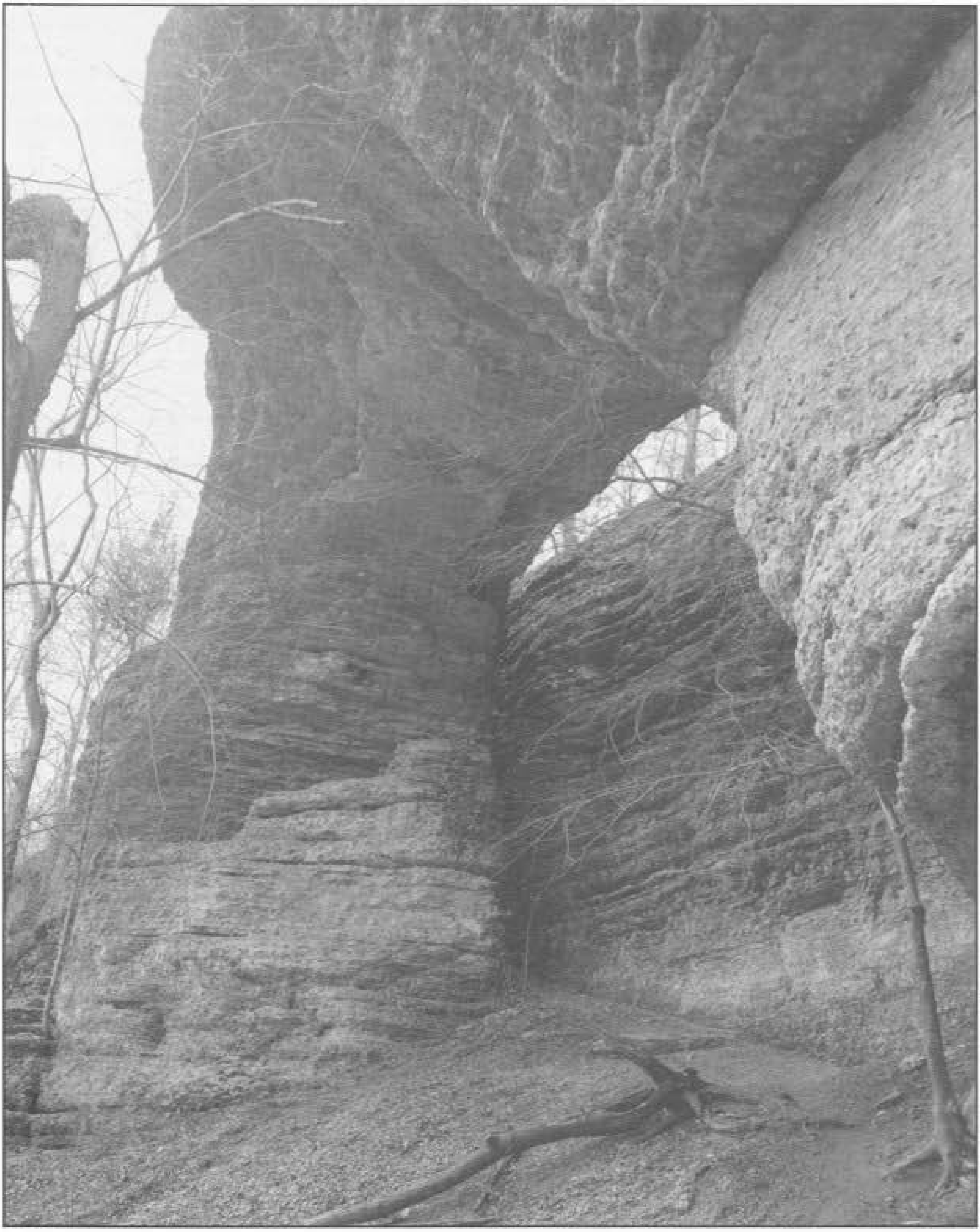


Figure 121

Hootentown Natural Arch in Stone County is one of the largest arches in the state. Photo by Jerry D. Vineyard.

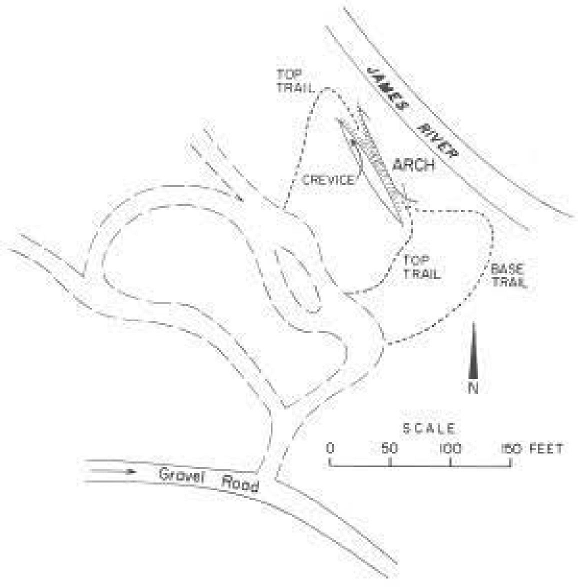


Figure 122

Trails lead to both the top and the base of Hootentown Arch.

The Arch may be reached by a variety of routes. South from Springfield on U.S. Highway 160 take the following route:

Miles

0.0	*Junction Highways 160 and O, 1 mile south of Highlandville. Turn west on O.*
6.3	*Turn left.*
6.5	*Cross Hootentown Bridge.*
6.6	*Turn left at T-junction.*
7.8	*Junction with Highway A; turn left onto A.*
8.15	*Bear left and continue straight ahead (east).*
8.6	*Entrance to parking area on left.*

Those entering the area from the northwest (e.g., via Clever) take the following route from the junction of Highways A and U:

Miles

0.0	*Junction A and U. Go east on A.*
1.7	*Bear left and continue straight ahead (east).*
2.15	*Entrance to parking area on left.*

267. THE NEEDLES EYE NATURAL ARCH

Wright County, 5 miles northeast of Hartville, on north side of Gasconade River, in SE¼ NE¼ NW¼ sec. 25, T. 30 N., R. 14 W., Fuson 7½-minute Quadrangle.

The Needles Eye is an unusual natural arch, for instead of being parallel to the bluff as are most natural arches in such an environment, it is at right angles to the bluff and forms a perforated flying buttress. Part of the bluff is overhanging, and the other part is tending to spall rather badly; thus even the most confirmed atheist would have to admit that this buttress was planned to strengthen the bluff. The buttress is composed of Jefferson City Dolomite and varies in width from 8 to 25 feet. It extends for approximately 40 feet from the bluff and contains an arch with a span of 20 feet and a maximum height of 10 feet. The arch is near the base of the buttress and has 30 to 35 feet of rock above the arch. See figure 123.

The arch was visited during the summer, but would be quite easily seen from the river during the winter. It trends S 20° E and is best photographed looking toward the west. Fortunately the topography permits standing on a bench at the base of the sheer bluff and above the talus slope and shooting horizontally to the west toward the arch. Foliage is not a great problem and there are options of visiting the arch in the summer by wading down the Gasconade, during the spring when the columbines are out, or in the winter when the visibility is the greatest.

The Needles Eye would rank as one of the most photogenic natural arches in the state and justifies the moderate effort needed to reach it.

It may be reached via the following route:

Miles

0.0	*Junction of Highway E going south and Highway 38 east of Hartville. Go north and east on Highway 38.*
1.2	*Turn left to the southwest off 38 onto gravel road.*
1.3	*Abandoned schoolhouse on right. Continue straight ahead to southwest.*

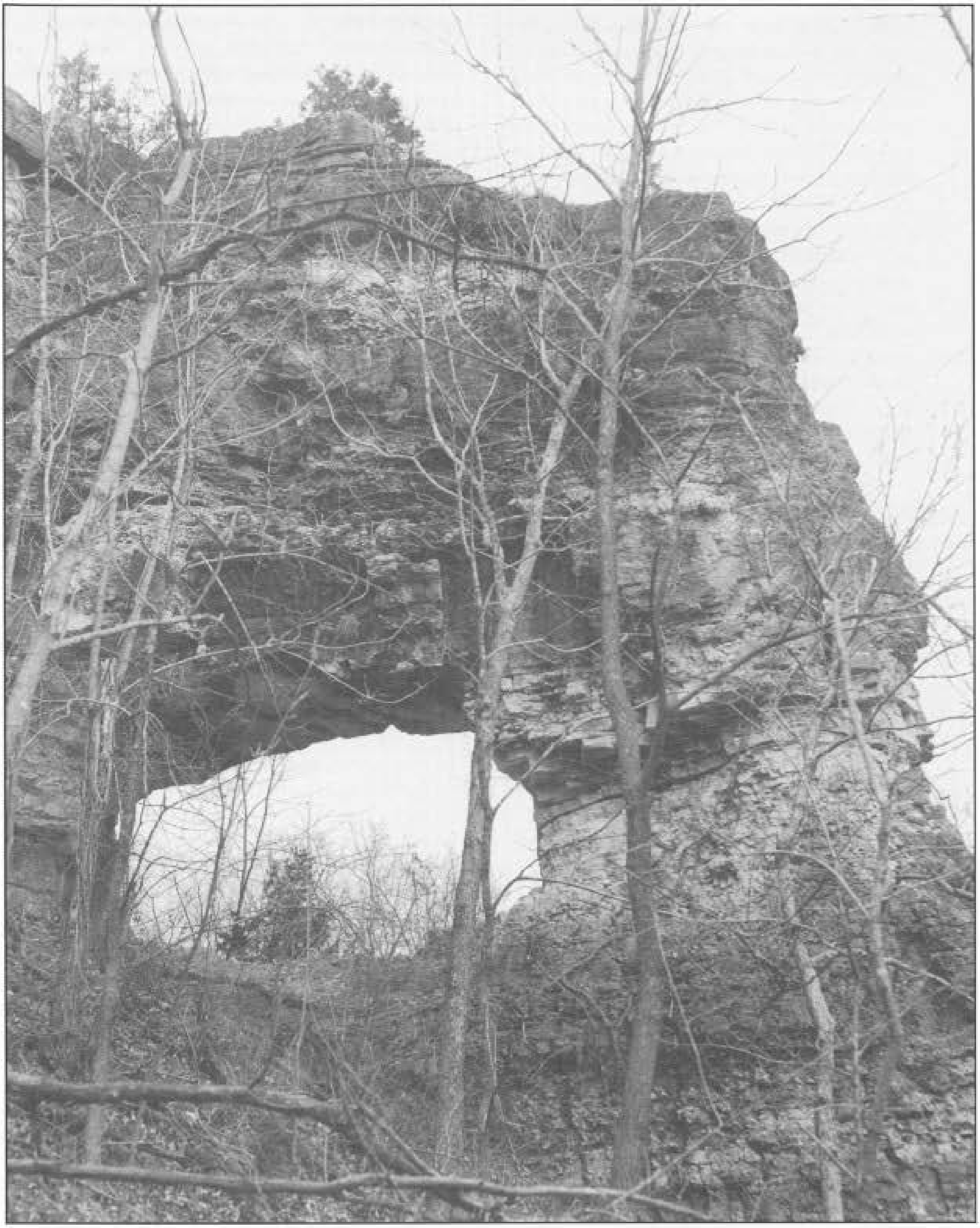


Figure 123

The Needles Eye Natural Arch in Wright County. Photo by Jerry D. Vineyard.

2.0 Road fork. There are two options at this point; either bear right up the hill to the west for an additional 0.25 mile and approach the bluff from the top, or park, walk to the put-in point and go downstream for about 0.25 mile and climb the bluff. The latter route was chosen because the Gasconade was low and easily waded, the weather was warm and the feasibility of an approach from top side was unknown. The river route is the harder and involves brush beating going up the slope. Those driving the additional 0.25 mile and using the upper route should walk to near the central part of the bluff line where the arch forms a promontory jutting out from the crest of the bluff. The view from this point is excellent and forlorn lovers should seriously consider this as a leaping point. Continuing to the west for about 200 feet, you can descend the bluff to some fissures, and double back toward the east along the bench at the base of the bluff near its contact with the talus slope. At the letdown point, erosion has produced structures that in a few thousand years will be the Devils Tea Tables or Balancing Rocks.

268. SLABTOWN NATURAL ARCH

Texas County, in west bluff of Big Piney River, 1 mile upstream from Slabtown Public Fishing Access, midway between Licking and southeast corner of Fort Leonard Wood Military Reservation, in SE¼ NW¼ NW¼ SE¼ sec. 21, T. 33 N., R. 10 W., Slabtown Spring 7½-minute Quadrangle.

Slabtown Natural Arch was not designed for the literally weak of heart. It is nearly 200 feet above the base of a Gasconade Dolomite bluff and could be reached from the base by following the very steep ravine it spans, or from the top of the bluff by descending a fairly steep slope.

The arch was approached by parking at the Public Fishing Access near Slabtown Spring at the north end of Highway AF and walking upstream along the east bank of Big Piney River. The walk was not easy and involved alternately staying near the water's edge and following a roller coaster footpath along a bluff. It was viewed from the east side of the river looking west because the stream was too deep to consider wading in late December.

Photographing this feature from the west side of the river is difficult because of the high angle and from the east side, the distance is too great. A helicopter would be a perfect base of operation.

The arch is estimated to have a span of 15 feet, a thickness of about 4 feet, and a width of between 5 and 10 feet. It is near the top of the Gasconade Dolomite, approximately 100 feet to the left of a pinnacle (as viewed from across the river) with a bulbous tip which is undoubtedly the property of the Devil and could be the Devils Pulpit, the Devils Tea Table, or the Devils Hassock.

The arch spans a very deep ravine in the sheer Gasconade bluff and the ravine, in turn, is probably a fissure resulting from solution along a vertical fracture with the arch representing a slender portion of the upper bluff which has not yet succumbed to erosion.

The steep slope above the arch is interrupted by large blocks of Roubidoux sandstone coated with green lichens, and occasional pine trees enjoy the acid sandy soil. Cedar trees (junipers) cling to the bare vertical Gasconade bluff and demonstrate their love of carbonate rocks.

The serious collector of arches would probably prefer to approach the site from the west side of the river and descend the caution-inspiring slope to the arch. The arch can be photographed looking eastward from this point. Several options are available in planning a visit to the arch. It is most easily reached by floating the Big Piney River with the alternates of viewing from the river or working up the steep slope. The eastern approach would not be an easy summer walk but is enjoyable during the winter.

The best map for reaching the area is the Mark Twain National Forest map which may be obtained from the U.S. Forest Service at Rolla. The Fishing Access was reached by taking Highway 32 northwest from Licking to its junction with N and following it to AF to the sign on the left which marks the Fishing Access road. The total distance from Licking to the access is 11.4 miles. This same access could be reached from the southern part of Fort Leonard Wood. Those wishing to descend to the arch from the west side of the river could go to the Paddy Creek area using the Forest Service map, and using the Slabtown Spring Quadrangle for reaching the arch which is 0.15 mile upstream from the junction of Paddy Creek with the Big Piney.

269. PADDY CREEK NATURAL ARCH

Texas County, at Paddy Creek Recreation Area, Mark Twain National Forest, between Licking and southeast corner of Fort Leonard Wood Military Reservation, near northwest corner sec. 21, T. 33 N., R. 10 W., Slabtown Spring 7½-minute Quadrangle.

Paddy Creek Arch is a double arch with a small natural tunnel and several smaller, vent-like perforations. The arch is high on the north bluff of Paddy Creek and requires wading this shallow creek from the parking area. It is easily visible as one follows the road downstream from the ford for slightly over 0.1 mile watching the bluff to the left or north until directly opposite the arch which is cave-like because of only partial lighting on the north side. After wading the stream, enjoy an interesting climb up a steep slope on or near a clay path resembling a giant otter slide. The climb is not dangerous, but the slide route affords excellent opportunities for slipping or rolling and its slickness attests to its popularity. The descent can be made most efficiently using the sitting-sliding method on the clay side; thus, old clothes are in order. The ascent was made to the east of the slide where ledge rock, sod, and vegetation toeholds abetted the climb of between 150 and 200 feet.

The main arch has a maximum height of 11 feet, a span of 20 feet, and a roof 12 feet wide and slightly under 12 feet thick at the thinnest point. To the right of the main arch, a slot arch 10 feet long and 3 feet wide offers a view to the east, and smaller perforations flanking this slot suggest that the site will be a meshwork in a few thousand years. A small tunnel constricts to a tight crawl exit to the northeast from the northeast corner of the main arch canopy.

The system is well worth the climb but conditions for photography are disappointing because the slope of the drainage through the main arch is so steep that inclined photography is necessary both above and below the arch. A telescopic shot might be more appropriate in this case.

To the west of the main arch is a shallow shelter cave with a portal of approximately the same dimensions as the arch. All of these features are developed in the upper Gasconade Dolomite close to the contact with the overlying Roubidoux sandstone. Steep dips of these formations upstream on the west are obvious from the parking area and major fracturing is strongly suggested, not only by these steep dips, but by the system of caves, arches, and slots in the dolomite. The westerly component of dip is approximately 15 degrees at the arch, increasing to 25 degrees at the cave. At the ford, upstream to the west, this dip has carried the Roubidoux sandstone almost to stream level.

Those not up to the climb to the arch will find the setting at Paddy Creek so entrancing that the visitation will be considered well worthwhile. The drive into the area is through pine forests and, at Paddy Creek, pines hug the Roubidoux sandstone which forms the upper part of 300-foot bluffs.

The arch enthusiast can continue southwest from the picnic area, following the road to near the Slabtown Arch (No. 268). The Mark Twain National Forest map is the best navigational aid for reaching the Paddy Creek area, especially if combined with a modern Missouri highway map. The area may be reached by turning off Highway 17 about 2 miles north of Roby or a mile south of the junction of Highways A, W, and 17, south of Fort Leonard Wood. From this turnoff, go northeast on County Road 2800 and thence southeast on Forest Service 220 to the Paddy Creek Recreation Area. It can also be reached via Highway 32 between Licking and Highway 17. The turnoff to the north is identified by a Paddy Creek Recreation Area sign.

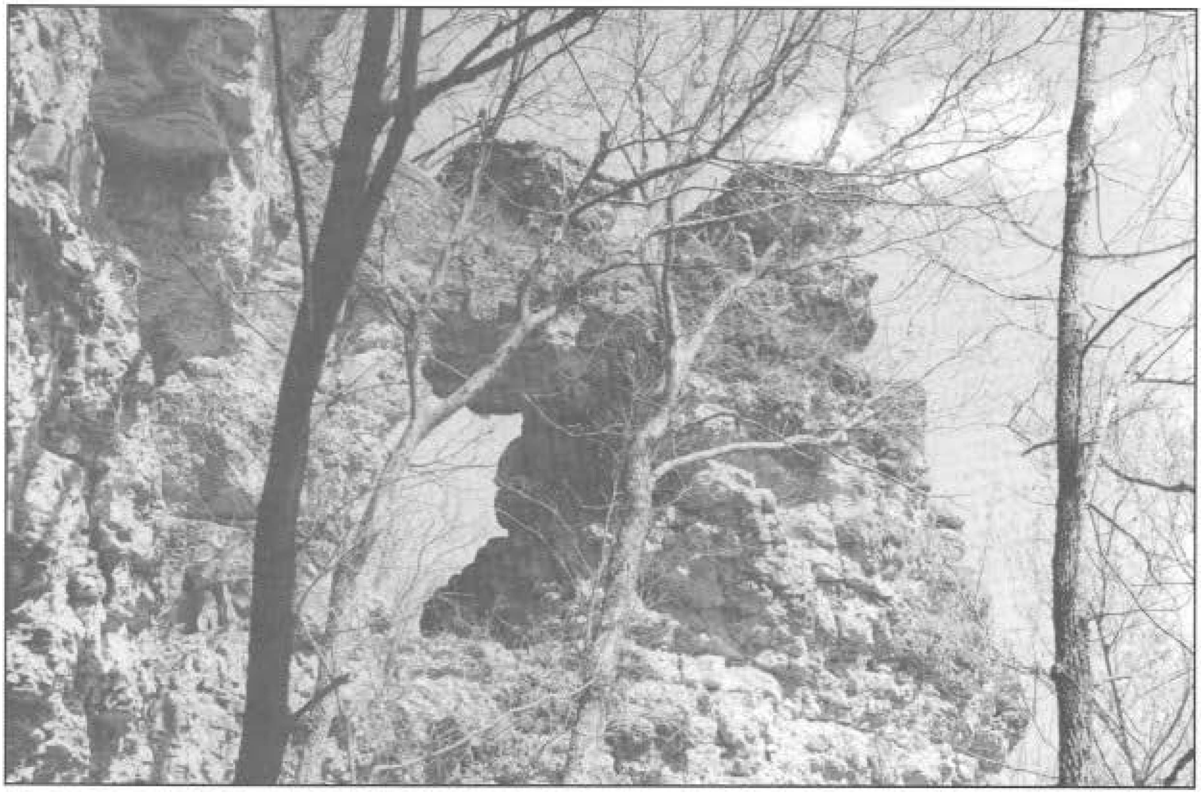


Figure 124

Devils Tables Natural Arches in Laclede County includes two natural arches and "tables" formed by resistant Gasconade Dolomite topping less resistant pedestals. Photo by Jerry D. Vineyard.

270. DEVILS TABLES NATURAL ARCHES

Laclede County, 19 crow-flight miles east-southeast of Lebanon or 15 miles southwest of Waynesville, in north bluff of the Gasconade River, SW¼ NE¼ SW¼ NW¼ sec. 26, T. 34 N., R. 13 W., Brownfield 7½-minute Quadrangle.

This site contains two natural arches, both with 6-foot spans and ceiling heights of 6 and 10 feet, respectively. The arches were developed in dolomites of the Gasconade formation and are associated with "tables" formed by the resistant Gasconade Dolomite topping less resistant pedestals (fig. 124).

As shown on the Brownfield 7½-minute Quadrangle the bluff line is exceptionally straight and probably follows an east-west fracture (joint) system. The arches themselves were also created in part by weathering along fracture systems. Although the features at this locale are less spectacular than many others in the state, the easy access and the view over the Gasconade valley justify a drive. Photography of the arches is most feasible in the winter when obscuring vegetation is at a minimum.

The site may be reached by the following routes:

Miles from Waynesville

0.0	*Junction I-44 and Missouri Highway 17 west of Waynesville; go south on Highway 17.*
12.1	*Enter Laclede County.*
15.8	*Right onto Highway U.*

16.1 *Right off Highway U onto gravel road.*

16.9 *Junction — continue straight ahead.*

18.2 *Junction — veer right (Nebo road to the left).*

19.7 *Junction — straight ahead.*

20.5 *Junction — straight ahead.*

21.0 *Cross Gasconade River.*

21.55 *Stop — parking pullout on left side of road; walk out onto bluff a few paces to the south.*

Miles from Lebanon

0.0 *Junction I-44 and Missouri Highway 32. Go south on 32.*

19.0 *Junction Highway 32 and Highway K. Turn left onto K.*

22.0 *Turn right off K onto gravel road.*

27.5 *Park at pullout on right side of road and walk out onto bluff a few paces to the south.*

271. DAVISVILLE NATURAL ARCH

Crawford County, 0.5 mile east of Davisville, in west bluff of Huzzah Creek, in Davisville Recreation Area, in SE¼ SW¼ NE¼ NW¼ sec. 29, T. 36 N., R. 2 W., Davisville 7½-minute Quadrangle.

David Butherus, graduate geology student at UMR, provided information on the location and measured dimensions of this arch. It is developed in the Potosi formation which consists of dolomite with drusy chert. Druse is an irregular layering of quartz with closely packed pyramidal crystals forming the surface (also colloquially called "mineral blossom").

The arch interrupts a steep bluff and has an opening 10 feet high on the upslope side increasing to 20 feet on the lower flank. The ceiling is 6 to 10 feet thick and the slice, which is perforated to form the arch, is 15 feet wide. This slice is parallel to the bluff line and is obviously fracture-controlled as is the bluff itself. Because it is on a steep slope, it is not easily photographed and visitation should involve precaution and surefooted personnel. The opening is on the flank of a steep sinkhole and the visitor is working in dimensions which are skewed toward the vertical.

At about the same horizon as this arch and 25 yards downstream, a cave with a 12-foot high by 8-foot wide entrance contains a vertical slot in the roof. This cave is almost identical in genesis to the arch and represents an earlier stage of erosion and weathering; thus, it will eventually produce a feature very similar to the arch.

A few yards farther downstream, a steep-sided canyon, terminating in a wet-weather waterfall, suggests a later stage than the arch. It contains huge blocks of dolomite and appears to be a collapsed cave-arch system.

These three sites are especially instructive in showing stages of development from cave-to-arch-to-canyon, and deserve visitation by all students of karst features who may be in the general area!

The site was reached by taking Highway 49 and 49A to Davisville; thence Highway V to the Davisville Recreation Area on the east side of Davisville Hollow and the west side of the Huzzah. Turn left off Highway V into the Recreation Area and go about 100 yards beyond the first turn out to a grove of young pine trees. The arch is near the crest of the bluff east of these pine trees.

The visitor may wish to continue to Red Bluff farther down the road beyond the pine trees. This bluff is stained red to brown by iron oxides (hematite and limonite, respectively) and locally black manganese oxides. These oxides are responsible for much of the high coloration in soils and sedimentary rocks of Missouri. The general area is attractive with a fine development of pines, pinnacling of the dolomite by differential weathering atop Red Bluff, and an attractive wading area at the base.

Huzzah Creek owes its name to the Osage Indians. Ramsay (1952, p. 39) makes the following statement regarding this name: *"The Osage, most important of all, pronounced* *their own name something like Wa-zha-ahe, which the white man turned into Hoozaw, Huzzah, or Whosau until the French made the more mellifluous Osage out of it."*

272. LEATHERWOOD NATURAL ARCH

Shannon County, 8 miles southeast of Summersville, on south side of Leatherwood Creek, NW¼ SE¼ NW¼ NW¼ sec. 13, T. 28 N., R. 6 W., Jam Up Cave 7½-minute Quadrangle.

Jerry D. Vineyard provided information on the location and appearance of this arch. It is a huge, slice-type arch facing north on the south side of Leatherwood Creek and is separated from the west-pointing spur by a slot-type fissure. It is comparable in size to Hootentown Arch (No. 266) and thus is exceptionally impressive, but difficult to photograph from the ground. It is in the Gasconade dolomite and owes its origin to a major fracture trending east-west which was enlarged to form the fissure which separates the perforated slice from the main bluff. Its location is remote; thus the visitor may wish to have the topographic map of the area and the adjoining Summersville NE Quadrangle plus appropriate transportation and foot gear for a forest trail journey.

Nearby (a few hundred feet upstream) is the huge entrance to Leatherwood Creek Cave, which should not be missed by anyone who hikes in to see the Arch. The cave entrance room offers welcome respite from summer heat and winter cold, and daylight penetrates several hundred feet into the cave.

273. DECATURVILLE NATURAL ARCH

Laclede County, 2.5 miles south of Decaturville and 4 miles northeast of Eldridge, 1 mile east of Highway 5, in north bluff of tributary to Dry Auglaize Creek, in SW¼ SW¼ NE¼ sec. 9, T. 36 N., R. 16 W., Eldridge East 7½-minute Quadrangle.

The term "arch" is somewhat misleading in describing this site because the interior form is that of a dome or igloo perforated at several points around its base. The maximum ceiling height is 8 feet and the maximum diameter is 30 feet. Originally the opening on the stream valley side was also about 30 feet wide, but it has been partly blocked by fallen rock slabs so that the main aperture of today is 10 feet wide. On the back or north side, a 7-foot wide aperture provides access from the upland area.

The rock material is finely brecciated or fractured chert of the lower Roubidoux. Instead of being joint controlled, this feature appears to be the result of weathering in an environment where the chert unit draped over a knob of dolomite. The knob was probably destroyed by dissolving action removing the dolomite, thus producing the cavity at the bottom of the inverted bowl-shaped mass of chert.

The site is not particularly photogenic, but is easily reached and a bit unusual in origin as contrasted with most of the natural arches described herein. Approximately 1.5 miles south of the Camden-Laclede County line, go east from Highway 5 for slightly over 0.5 mile on a gravel road. Where this road turns sharply south, park and walk eastward for slightly under 0.25 mile watching for the perforations in the bluff on the north side of the tributary at the most northerly part of its kinked course.

274. NASH NATURAL ARCH

Shannon County, 2 miles east of Eminence, in W½ SE¼ SW¼ SE¼ sec. 30, T. 29 N., R. 3 W., in bluff on east side of Shawnee Creek, Eminence 7½-minute Quadrangle.

The location of this arch was supplied by Mr. John Baz-Dresch in a letter dated May 11, 1975. No description was available.

275. GRANDGLAIZE NATURAL ARCH

Camden County, 1.2 miles north of Toronto, in west bluff of Grandglaize Creek, in NE¼ NW¼ NE¼ sec. 24, T. 38 N., R. 15 W., Toronto 7½-minute Quadrangle.

Grandglaize Natural Arch was not visited because access was refused. Mr. Robert Hooper of Ozark Caverns kindly supplied information on the location of this feature. It is near the crest of the east-facing bluff on the west side of Grandglaize Creek, so close to the north line of sec. 24, that it may straddle the line between sec. 24 and sec. 13 to the north. Mr. Hooper describes it as being parallel to the bluff line and representing a remnant of a sinkhole whose vertical axis slants to the east. Truncation of this feature by erosion on the east side has produced the arch. It is close to a pair of caves below it.

If access could be obtained, the easiest route would be via the private road going west off Highway C near the center of the NE¼ sec. 19, T. 38 N., R. 14 W.

276. MARMATON NATURAL ARCH (JDV)

Vernon County, in SE¼ SW¼ NW¼ NW¼ sec. 9, T. 36 N., R. 31 W., Horton 7½-minute Quadrangle.

An attractive and well-proportioned natural arch in sandstone along the Marmaton River in Vernon County has the distinction of being the most shabbily treated natural arch in Missouri; it is used as a dumping ground (fig. 125). The new alignment of U.S. Highway 71 crosses twin bridges over the Marmaton River about 0.25 mile south-southwest of the old highway as it is shown on the Horton 7½-minute Quadrangle. The natural arch is in an outcrop of sandstone that forms a bluff line on the east bank of the river.

The arch can be seen from the northbound lane of the highway in the winter, but in summer it would be well hidden by vegetation. The visitor can park along the shoulder on the southeast side of the river, and either walk along the floodplain to the base of the arch or walk along the ridge to the sinkhole that separates the rock span from the bluff line.

The arch spans about 35 feet and the height is about 5 feet. On the ridge above the arch there is a small, oblong sinkhole about 10 feet long and 6 feet wide, which has collapsed into a cave-like opening below, leaving behind a rock span about 8 feet wide. Local people — perhaps the owners of the land — have used this small sinkhole as a dump and it is filled with cast-off toys, rolls of fence wire, plowshares, and even a cast-off vacuum cleaner. Part of the floodplain below the arch is also littered with barrels, tin cans, and other discarded items.

The thick-bedded Pennsylvanian sandstone crops out for a distance of several hundred yards. The sandstone is cross-bedded and the careful observer will note interesting fretwork patterns on the rock if he chooses the floodplain path to the arch. Just beyond the arch there is a jumbled pile of sandstone boulders that interrupts the smooth, moss-covered face of the outcrop and suggests that the Marmaton arch of today may be only the latest in a succession of such structures that developed along this particular outcrop of sandstone.

277. ARCH EDDY NATURAL ARCH

Laclede County, 22 miles southeast of Lebanon, in east bluff of Gasconade River, 1 mile downstream from Missouri Highway 32 bridge, near center E½ sec. 3, T. 33 N., R. 13 W., Winnipeg 7½-minute Quadrangle.

According to Mr. Dale Gravens, who operates a cabin and boat rental at the Highway 32 bridge, Arch Eddy, although not so identified on the Winnipeg Quadrangle, is named after a natural arch in the east bluff of the Gasconade.

He describes the arch as being about 0.25 mile below the mouth of Mill Creek and near the base of the bluff. Mr. Gravens estimates the arch opening as between 10 and 15 feet in diameter and the length of the passageway as about 15 feet. This site would be most easily reached by boat.

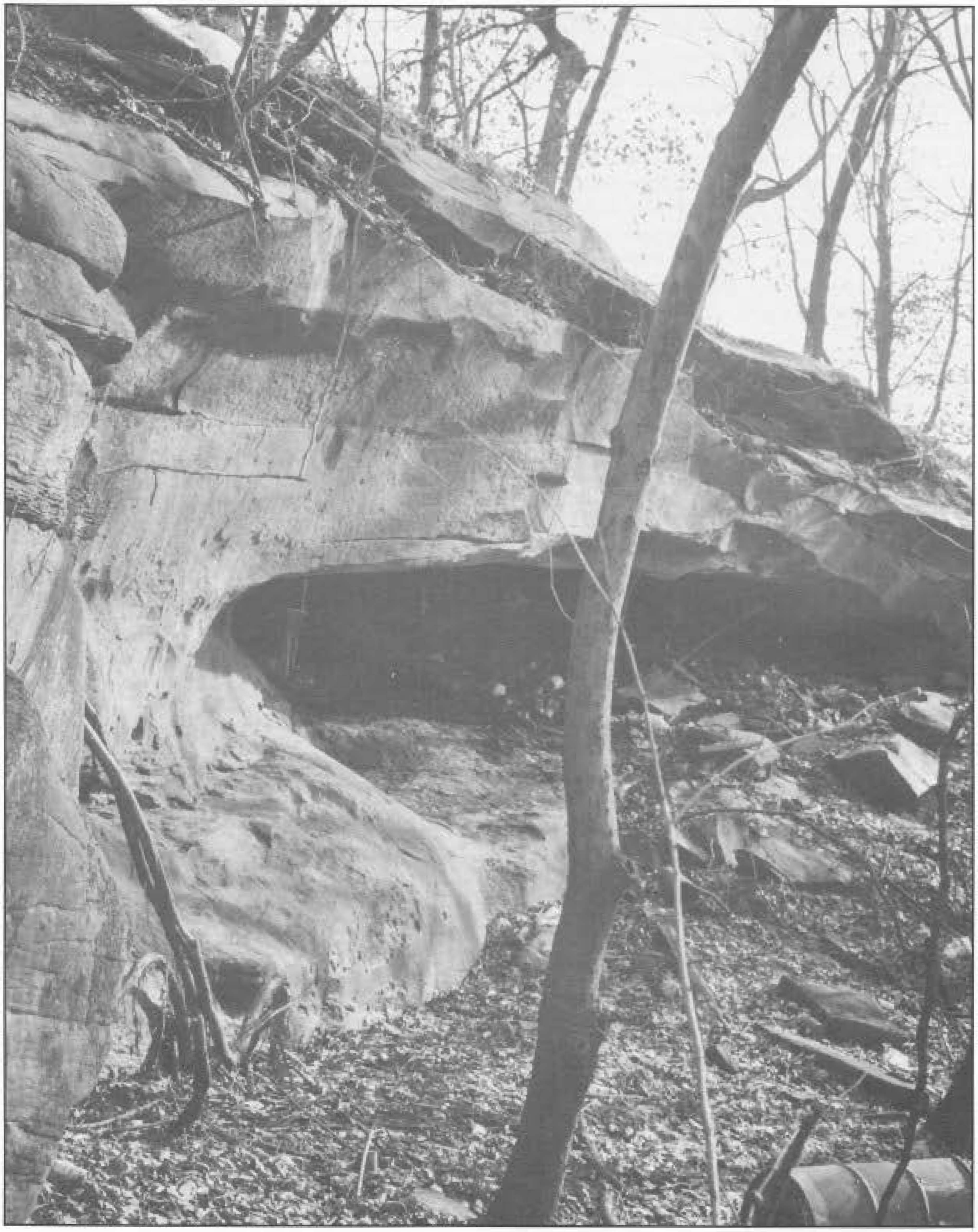


Figure 125

Marmaton Natural Arch in Vernon County. Photo by Jerry D. Vineyard.

NATURAL BRIDGES

278. CLIFTY HOLLOW NATURAL BRIDGE

Maries County, 10 miles northeast of Dixon, in Clifty Hollow, SE¼ NE¼ NE¼ NW¼ sec. 12, T. 38 N., R. 10 W., named on Nagogami Lodge 7½-minute Quadrangle.

This is one of the most popular natural bridges in Missouri for photographers, even though it requires a mile walk to reach it. It may be photographed successfully in any season and throughout the daytime (fig. 126).

Despite its remote location, this bridge was mentioned by Broadhead (1873, p. 16) in one of the early reports of the Missouri Geological Survey. He described it from field work done in 1857 and regarding its setting said:

> *"A perfectly clear stream of water courses through this valley. The bottoms near are overspread with a dense growth of trees and vines, among which I noticed the Muscadine grape. The valley at this point, being shut in by its perpendicular cliffs, with not a path to guide the traveler through the dense thickets, is wildly picturesque and romantic in its loneliness."*

This description is still apropos more than a century later. It may be reached by two routes: From Dixon, starting at the junction of Highways 28 and C, follow Highway 28 for 3.9 miles northeast out of Dixon and turn right (east) off Highway 28 onto Highway W. Follow this road for 5.6 miles and park at the picnic area on the left at the bottom of a hill a few yards short of a concrete-slab stream crossing.

It may also be reached from the north by taking Highway 28 south from Highway 63, 2 miles south of Vienna. Stay on Highway 28 for 11 miles from this junction and turn left (east) onto Highway E (those having topographic maps can shorten this route via gravel roads). Follow E past the Hayden Store, turn right off E 3.45 miles east of Hayden, then go south for 1.9 miles to a pullout on the right, a short distance beyond the third ford or low water bridge encountered after turning south.

The area near the pullout offers the attraction of a popular wading (or shallow swimming) area in the shadow of vertical bluffs of Gasconade Dolomite with a hanging valley which forms a wet-weather waterfall from the top of the bluff 100 yards upstream from the pool. Clifty Spring to the south of the pullout supplies a small stream containing water cress.

Even the etymologist can find joy in this area, for the term "clifty" exemplifies a preservation of archaic English. Walker's 1823 dictionary lists clift as a synonym for cliff, but by 1864, Webster considered clift obsolete.

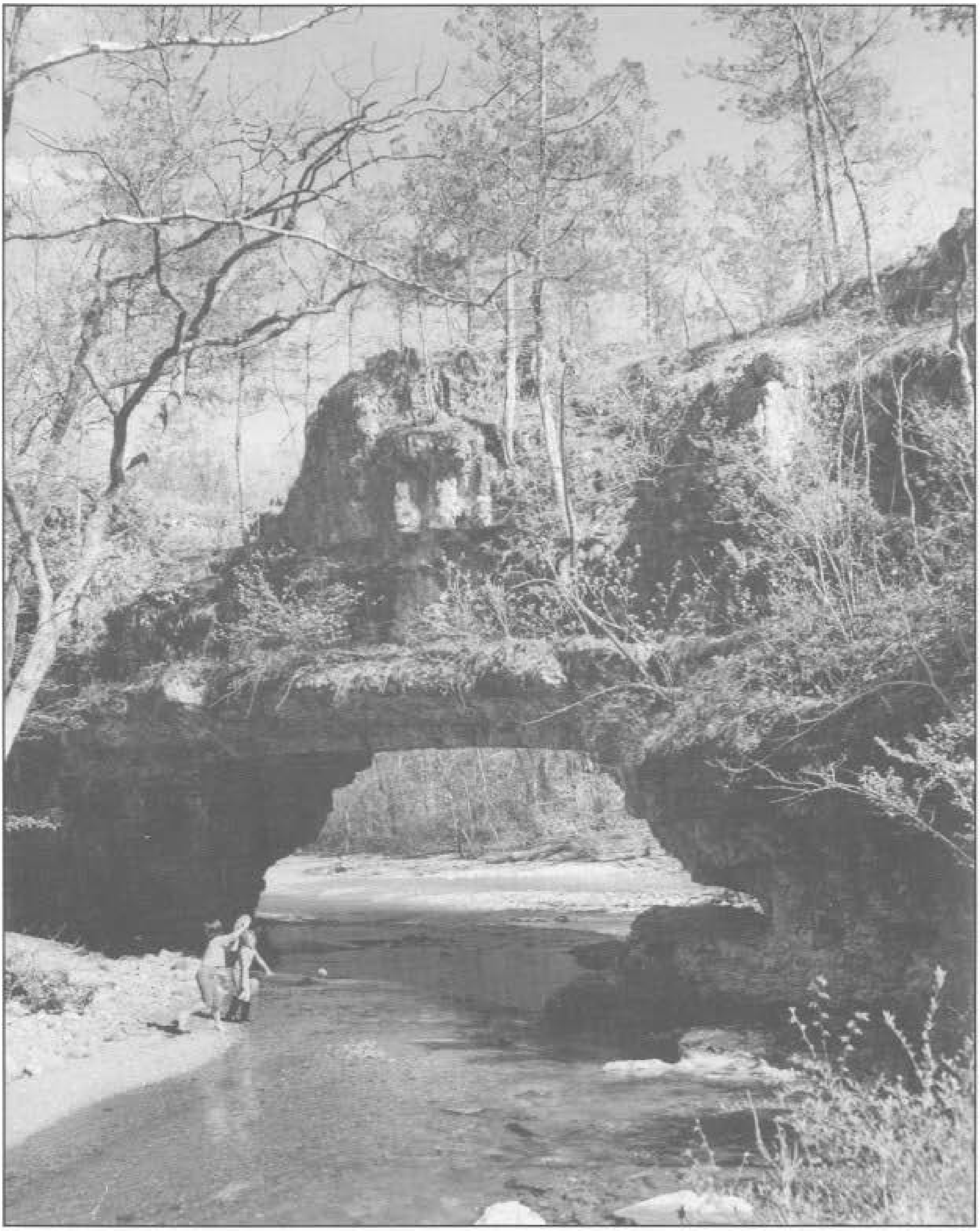


Figure 126

Clifty Hollow Natural Bridge is one of the most popular in the state. Photo by Jerry D. Vineyard.

Although the walk to the natural bridge is approximately a mile, it is well worth the effort, especially in the spring or fall. The easiest route involves walking in or aross the channel of Clifty Creek; thus overshoes or hiking boots are in order. There is no marked path, and the best route is in or close to the channel much of the way, passing scenic overhanging bluffs on the left for at least a quarter of a mile. After the long stretch of overhanging bluffs, one encounters a bluff on the right, then one on the left, and then one on the right in which the strata dip or slope noticeably downstream. At this last bluff, large blocks of dolomite have tumbled into Clifty Creek. Upstream from this bluff the creek is near the center of the valley; bear right to the bridge, which interrupts what appears to be a bluff, but actually is a ridge or spur.

The bridge is developed where a tributary of Clifty Creek goes through a spur of Gasconade Dolomite which originally formed a more lengthy divide between this tributary and the main channel. As shown in figure 127, the tributary at one time joined Clifty downstream from the natural bridge. At some time in the

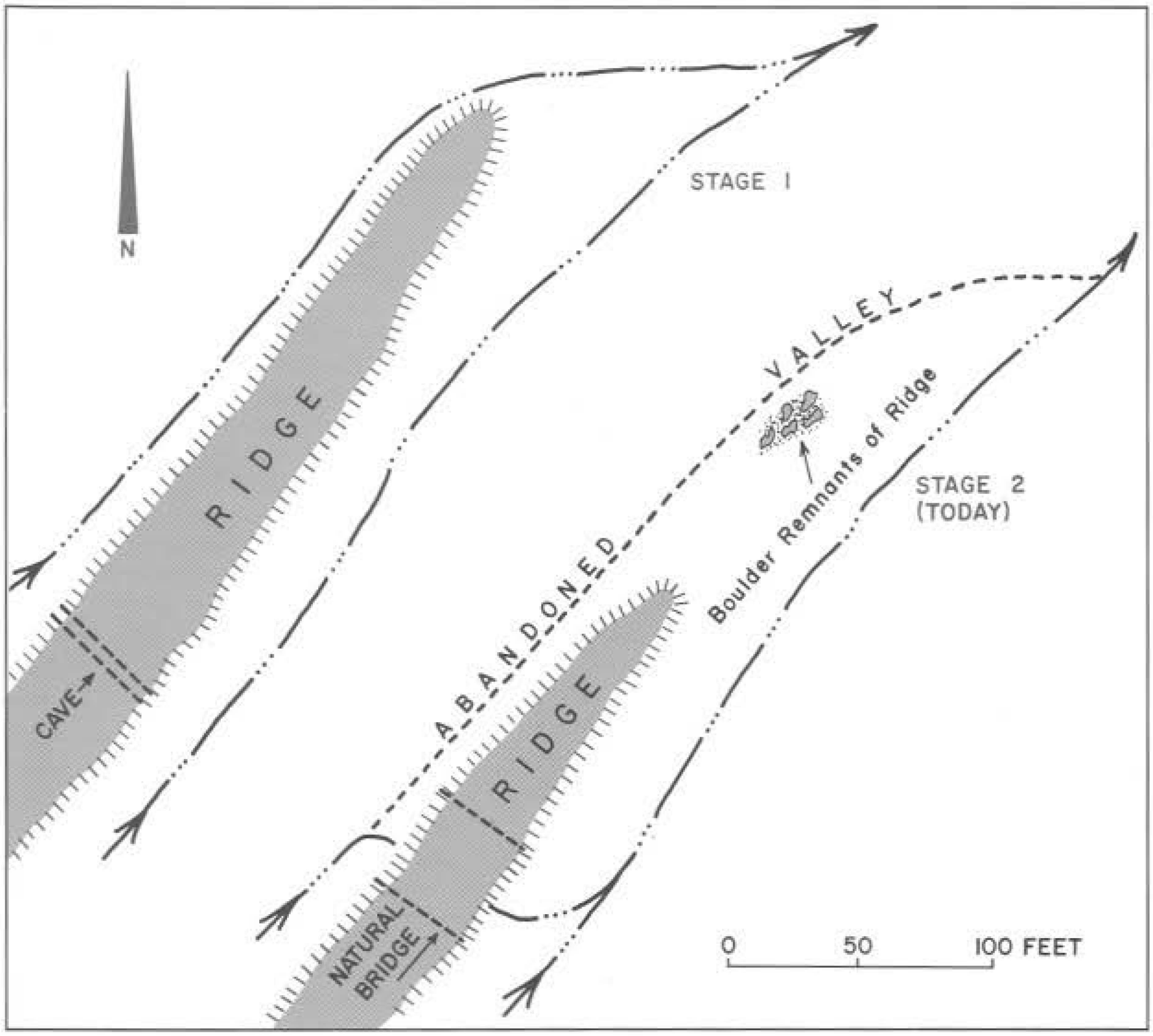


Figure 127

Development of Clifty Hollow Natural Bridge by lateral piracy. Sketch is partly diagrammatic and is not to scale.

geologic past, the tributary took a shortcut through the ridge, probably following a joint enlarged to a fissure by water erosion.

The arch has a span of 40 feet and is 13 feet high. The ridge in which it is formed is 40 feet high and 25 to 30 feet wide, the variation in width being in part the result of undercutting by Clifty Creek on the south side which makes it narrower at the base. Tumbled blocks of dolomite east of the present nose of the divide in which this bridge was developed hint at the collapse of an older natural bridge at a time when this divide extended farther to the east.

Jointing was the major factor in the development of the bridge and the ridge in which it is formed. Thick-bedded chert in the streambed at the north entrance to the bridge has major joints trending N 50° E, parallel to the ridge and the main trend of Clifty Creek. Closely spaced joints or fractures trending N 45° W in this same chert trend parallel to the walls of the bridge. The ridge was probably developed along major joint planes and the bridge was formed by solution enlargement of fractures or joints penetrating the ridge.

About 350 yards downstream from the bridge, a shallow cave in the north bluff on the west side of a main tributary forms another natural arch. The cave is only about 15 feet deep and has an entrance on the main bluff side and another facing the tributary valley. The cave ceiling is about 6 feet high and the arch in the main bluff has an opening some 15 feet wide at the base. Ashes and other litter give some credence to the tradition of this having been a hermitage (third class).

COURTESY COSTS SO LITTLE
BUT IT PAYS SO MUCH...
Be A Courteous Visitor

Ten yards west of the north-south fence line between secs. 1 and 6 the north bluff is perforated by a tunnel roughly parallel to the bluff face. The tunnel is about 12 feet above the top of the slope leading to the vertical bluff where the bluff has a slight promontory. A length of 15 feet and a diameter of 3 to 4 feet make this tunnel a crawlway rather than a strollway.

279. NATURAL BRIDGE ROAD NAMESAKE

St. Louis, at junction of Natural Bridge Road (Palm) and 23rd Street, Granite City, Illinois-Missouri 7½-minute Quadrangle.

This natural bridge has had excellent publicity but unfortunately it is a has-been victim of urbanization. Hertlich (no date, p. 33) described the road and bridge as follows:

"Natural Bridge road was so named because its original right-of-way passed over a natural stone arch under which flowed Rocky Branch Creek, which had its source somewhere in the western part of the city near Page avenue. It is said to have been a picturesque stream with a rocky bottom and a shore lined with stone ledges leading up to the massive stone arch which was in the vicinity of Salisbury avenue. There were many spring-fed streams in this section of North St. Louis, among them Gingras Creek, which had its source in what is now known as Pine Lawn, where Natural Bridge road enters the county. The banks of these streams were densely wooded and in the early days were the haunt of the beaver, otter, muskrat, mink, raccoon and other fur-bearing animals which fell prey to the French trappers, who built their modest log cabins near the water's edge.

"On June 3, 1845, according to court records, John Goodfellow and James F. Walton were named commissioners to view and lay out Natural Bridge road as a continuation of West Mound street in the City of St. Louis, thence over Sixteenth Street, then the western city limits, and along the Mrs. Wright's Addition, thence through the St. Louis Commons to the fork of Owens Station road and the road that

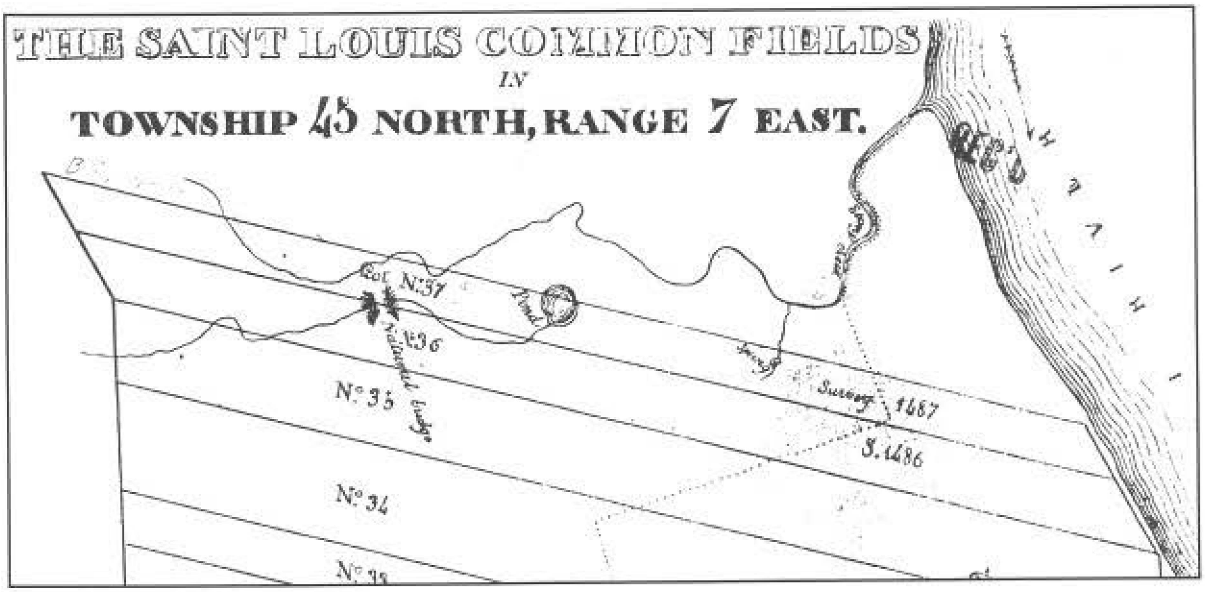


Figure 128

Natural Bridge was clearly noted on an old map of "The Saint Louis Common Fields," but no trace of it — not even the bronze plaque that once noted its location — remains in the highly urbanized area today.

leads to Florissant. On September 8, 1848, another entry is in the shape of a letter from Charles Semple asking that repairs be made on Natural Bridge road which passes over the stone bridge in the Prairie, near the Chouteau home.

"The Natural Bridge Plank Road Company was incorporated in 1851 and during that year and the next it constructed a single-track plank road at a cost of $120,000."

Scharf (1883, p. 773) in discussing the problems of draining the sinkhole or basin areas of St. Louis says:

"The principal basins were as follows: Beginning on the north, the ridge at the southwest of Gingras Creek enclosed a broad depression that had no surface outlet. Then in the vicinity of Fifteenth and Benton was another region that required artificial drainage. From this range southward along Twentieth Street runs a rocky ridge which constitutes a divide between the river slope and a depressed region farther west. This depression was formerly filled with sinkholes, the drainage of which had cut natural channels through the rocks under the ridge. Rocky Branch found its way under the divide by these channels and broke out on the eastern slope. From the fact that the ridge, so to speak, bridged these drains, it was called the Natural Bridge."

Mr. Norbury L. Wayman of St. Louis supplied the most definitive information yet known about the natural bridge for which Natural Bridge Road was named. Mr. Wayman found a map of "The St. Louis Common Fields" in Dupre's 1938 *Atlas of the City and County of St. Louis* (fig. 128).

The old map clearly shows a rock bridge at what is today the intersection of Palm and 23rd Streets. The map shows that a small stream passes under the bridge and ends in a round pond with no outlet. However, just to the east is a spring that flows into Stony Creek, then into the Mississippi River. One possible explanation is that the natural bridge was an isolated small segment of a cave system that once included most of the stream valley, as well as the segment from the pond to the spring, which is still intact. As St. Louis grew the natural features were slowly channelized, filled, built over, and otherwise obliterated. Now the several springs, sinkholes, and the "Big Mound" shown on Dupre's map are no longer discernible.

280. BLACKBEARD'S CACHE NATURAL BRIDGE

Jefferson County, 1 mile southwest of Festus and 0.2 mile south of head of Harrison Lake, in center E½ SW¼ SE¼ NE¼ sec. 11 (projected in part), T. 40 N., R. 5 E., Festus 7½-minute Quadrangle.

Thanks to the horse, Jesse James and crew thoroughly covered Missouri in a relatively short period of time, but Blackbeard the Pirate chose the hard way to leave his calling card. According to Rutledge (1970, p. 174), exceptionally high waters during the rainy season permitted Blackbeard to go up the valley of the Joachim and into the area that is now Harrison Lake. Receding water left his pirate vessel stranded in the Harrison Lake area and his loot was buried near the natural bridge south of the present lake. The ship was then rolled on logs for 4 miles overland to be launched in the Mississippi River near Crystal City.

The bridge is not large but it is easily reached and photographed. Its attractiveness is enhanced by a 7-foot, wet-weather waterfall located 12 feet upstream from the bridge. Obviously the bridge is an example of subterranean stream piracy created by the stream discovering a small cavern in its bed and going underground. Enlargement of the cavern entrance produced the miniature canyon between the waterfall and the natural bridge. The valley floor at the crest of the waterfall projects downstream to the top of the bridge which remains as evidence of a former channel bed as well as the lip of a former waterfall.

The bridge has a span varying from 5 feet at the bottom of the stream valley to a foot or two at the top. The shape of the bridge opening is evidence of a fracture paralleling the center of the stream valley which was enlarged to form the cavern and subsequent natural bridge. The roof has a minimum thickness of slightly under 2 feet, and the width of the bridge varies from 7 to 10 feet. The face of the waterfall dropoff and the flanks of the bridge are determined by fractures trending N 60° W, at right angles to the stream which conspired with the vertical fractures parallel to the stream to produce the falls and bridge. Medium- to thin-bedded Joachim Dolomite was the host for this minor stream piracy which, in turn, may have been the host for the pirates' cache. The treasure legend has apparently been taken seriously by some and resulted in small-scale digging.

Figure 129

Legend has it that Blackbeard the Pirate buried his loot near a natural bridge in Jefferson County. Drawing by Randal Rinehart.

The site was reached by the following route:

Miles

0.0	*Junction Highways A and 21A at west edge of Festus. Go left on 21A.*
0.7	*Three-way stop. Turn left off 21A and then bear right at large circular storage tank where road forks.*
1.35	*Gravel road dips into valley. Park and go down valley (northward) for about 0.125 mile to point where valley is crossed by the natural bridge.*

281. IRONDALE NATURAL BRIDGE

Washington County, 2 miles northwest of Irondale, SW¼ SE¼ NW¼ sec. 9, T. 36 N., R. 3 E., Irondale 7½-minute Quadrangle.

Irondale Natural Bridge is pocket-size but photogenic. The best photo is taken facing west of southwest suggesting a visit early on a summer morning or on an overcast day. A visit on a cold day when the streams are up is not recommended because a bit of stepping stone fording is involved. This fording degenerated (or blossomed) into wading both coming and going as the writer slipped off well-rounded, widely spaced stepping stones.

The arch spans a northeast-draining tributary to Wallen Creek. This tributary heads near the center of SW¼ sec. 9 and joins Wallen Creek about 0.25 mile northwest of the section. It has a span of about 15 feet, a ceiling height of 5 feet, and is of slender design with a minimum width and ceiling thickness of 3 feet.

Obviously it is a remnant of a small cave, for a few yards upstream, the valley floor drops about 6 feet at a waterfall. The top of the arch is a remnant of the dolomite streambed before drainage went underground somewhere between the arch and the waterfall.

The baby canyon between the two features was once part of the wall of a small cave. The cave inlet in the floor of the valley enlarged as the roof was destroyed. This enlargement terminated with the falls on the upstream side of the stream entrance, with the arch remaining as a relic of the downstream part of the cave.

RULES FOR THE USE OF
PUBLIC LANDS
ARE TO PROTECT YOU ...
AND THE LAND ...

The rock is Potosi Dolomite and the route to the arch passes Potosi quartz druse fragments in the streambed. These banded quartz crystal-chert associations, colloquially called "mineral blossom," have been tumbled by stream action and resemble colorless agates.

The arch is delicately attractive, readily found, and easily reached despite the possibility of wading. It was reached via the following route:

Miles

0.0 *Junction of Highways U and M at south edge of Irondale. Go west on U.*

0.7 *Cross Big River.*

2.4 *Cross Wallen Creek.*

3.0 *Park at iron gate on south side of U on east side of small tributary draining south into Wallen Creek. Follow trail to southwest across this tributary and then old lane heading south by southwest. At end of lane, bear right up Wallen Creek, fording it whenever one can and entering main tributary on south side of creek. This tributary is about 0.125 mile upstream from the end of the lane. The arch spans the tributary, thus it could be missed only by a myopic midget.*

282. WATER OAKS NATURAL BRIDGE

Crawford County, on east side of private road into Water Oaks Ranch, 6 miles northeast of Steelville, in SW¼ SW¼ NW¼ SE¼ sec. 6, T. 38 N., R. 3 W., Leasburg 7½-minute Quadrangle.

Water Oaks Natural Bridge is a typical example of subterranean stream piracy with conspicuous remnants of the old stream valley floor well preserved. The bridge, composed of Gasconade dolomite and chert, is immediately below the juncture of two steep, northeast-draining ravines. It has a maximum span of 12 feet, a ceiling height of 4 to 5 feet, and a ceiling thickness of 4 feet. The passageway is 18 feet long.

If one projects a remnant of the old stream valley, a flattening atop the space between the two valleys, across the top of the ridge, it is obvious that water once flowed over what is now the bridge. This old valley floor was approximately 9 feet above the present valley floor and further preservation of it can be seen in the southeast ravine where it forms the lip of a wet-weather waterfall which drops to the more modern valley floor. As is typically the case in such subterranean stream piracy, the stream found a cave outlet in its prior bed between today's natural bridge and the waterfall upstream. This cave enlarged to produce the natural bridge and the small-scale canyon between the bridge and the waterfall. The influence of jointing in abetting the piracy is obvious, for the bridge follows parallel vertical fractures trending almost due east-west.

Although the bridge is not an unusual photographic subject, it is certainly impressive enough to earn a visit. Photography is best when looking west, upstream toward the downstream face of the bridge.

The site was reached from Steelville by driving east on Highway 8 for approximately a mile to the junction with Highway TT. From the junction of these two roads, follow TT north and east for 4.2 miles to a sign on the left identifying the Water Oaks Ranch. The lane leading off to the left (a general northerly direction) from this sign was followed for an additional 1.45 miles to a very faint trail leading to the right. This trail has *two* junctions with the private road, the northern one being the more obvious. The trail was followed on foot for a bit over 0.1 mile to where it bears left (north) to an open field. At this point the steep ravine, the first one south of this field, was followed downstream for about 500 feet to the natural bridge at the juncture of this ravine and one to the southeast of it. Because the new bridge is on private (POSTED) territory, access permission should be obtained. Cleo Yancey of Steelville kindly brought this site to the writer's attention and acted as guide.

WHEREVER YOU GO,
THERE YOU ARE...

283. STEELVILLE NATURAL BRIDGE

Crawford County, in ravine in south bluff of Meramec River, at north edge of Steelville, in NW¼ SE¼ SE¼ sec. 28, T. 38 N., R. 4 W., Steelville 7½-minute Quadrangle.

The Steelville Natural Bridge is modest both in size and in degree of self-advertisement. Many living in the area had never heard of it, but an exceptionally accurate lead regarding the location made it easy to find.

The bridge has a maximum span of about 15 feet at the base and a roof height of 4 to 6 feet. It is only 2 to 3 feet thick and several feet wide. As is the case at the Irondale and Blackbeard's Cache Natural Bridges, a low waterfall is a few feet upstream from the bridge, the intervening plunge pool representing an area of destroyed roof of a shallow cavern or an enlarged fracture. The falls are 5 to 6 feet above the valley floor and only 4 feet upstream from the arch.

Joints are conspicuous as the culprits responsible for the site because the flanks of the bridge and the lip of the waterfall all trend N 30° E along vertical fracture surfaces in the Gasconade Dolomite. This direction is approximately parallel to the trend of the bluff line at the mouth of the ravine and suggests the further influence of fracture control on a larger scale.

The topographic map is a useful navigational aid for two possible overland approaches to the arch. The Wildwood Resort is shown on the map as a large, angular building near the north line of sec. 33. This map shows a trail going west between the highway and the resort and then angling slightly east of north down to the river. This trail was followed to the riverbank and then the rock debris slope above the river was followed along a faint path of the first ravine downstream from the end of the trail.

The bridge is somewhat of a fooler because several old concrete foundations and culverts along the trail so impressed the mind that the natural arch viewed from the mouth of the ravine appeared to be another abandoned concrete bridge with perfectly vertical sides. Poor footing did not permit accurate pacing but the arch is estimated to be 100 yards up the ravine from its mouth.

This site should be visited for photography when the foliage is at a minimum. It is best photographed looking up the ravine to the southeast although such a view does result in an angle shot because of the steep ravine slope. The visitation was made under ideal conditions, namely a winter day with comfortable temperature and the ground sufficiently dry to minimize danger of slipping on the ankle-twisting talus slope to the valley. The trip was worth the effort but might not justify a midsummer hike.

An easier approach would be via the Meramec, using a wooden pumphouse with a concrete foundation as a landmark to the end of the trail leading from Wildwood to the river. Another approach would be down the ravine containing the arch, leaving the road near the southeast corner of sec. 28 and following this ravine which is indicated on a topographic map by contour lines "V-ing" toward the extreme southeast corner of the section.

284. MARBLE CREEK NATURAL BRIDGE

Iron County, 7 miles southeast of Ironton on Marble Creek, near center west line NW¼ SW¼ NE¼ sec. 3, T. 32 N., R. 4 E., Des Arc NE 7½-minute Quadrangle.

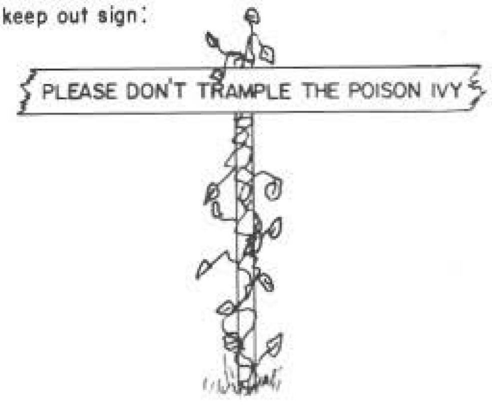
A more appropriate name for this natural bridge might be "Low Water Natural Bridge" because only the crest of this bridge was visible at the time the writer exhumed enough of it to assure himself that it is a natural bridge. James Connelly, the dean of Iron County naturalists, supplied the location, but the first and unsuccessful attempt to find it was made in the spring when the water was high. A return was made in late July when the crest of the bridge was outlined as a 4-foot wide band of limestone, connecting a broader exposure of limestone on either side of the creek. Upstream from this band was gravel at the same elevation; downstream was a shallow swimming hole.

On the downstream side of the bridge, a slight overhang of limestone gave a hint of the bridge's existence and hand excavation of gravel on the upstream side caused the water to rush under the clogged bridge and to assist in enlarging the opening. Sufficient excavation confirmed that the upper part of this natural bridge has a span of at least 3 feet which appears to deepen with depth. The ceiling of the arch is only a foot thick and the height from ceiling to floor cannot be determined because of the gravel fill.

Local residents tell of swimming in the hole and going under the bridge and Mr. Connelly gave a description from memory confirming that a larger portion of the bridge was formerly exposed and that it has been nearly buried in the last two decades. The majority of Missouri caves were not made by surface erosion, but in a subterranean environment; thus this cave-related bridge may enlarge appreciably at a depth far below that of the present stream channel.

A prominent joint on one side of the bridge trends N 65° W or roughly parallel to the course of the stream suggesting that the original fracture or fractures which were enlarged at depth to produce the natural bridge or its ancestral cave trended in approximately the same direction. This bridge was reached via the following route:

Effective keep out sign:


PLEASE DON'T TRAMPLE THE POISON IVY

From the junction of Highways E and 21 at the south edge of Ironton, go south on 21 for 6.35 miles. At this mileage after crossing a low water bridge, stop at the first house on the right to obtain access. A hike to the southeast from this house across the bottomland leads to a shallow swimming hole and a broad expanse of limestone sloping or dipping upstream. Near the center of this stream the exposure of the limestone is reduced to that of a broad walkway which represents the crest of the natural bridge. Perhaps at some time in the future, pressure from the younger generation will result in excavation of gravel (which has filled much of the swimming hole) and exposure of more of the natural bridge.

Those driving south on Highway E should make plans to visit the Marble Creek Shut-In (No. 73) and others to the east en route to Fredericktown.

285. CRIGHTON NATURAL BRIDGE

Greene County, at southeast edge of Springfield, on Natural Bridge Farm (George A. Crighton, owner), in center NW¼ SE¼ NE¼ sec. 3, T. 28 N., R. 21 W., Galloway 7½-minute Quadrangle.

The combination of easy access, well-groomed environs, an impressive gorge, and a variety of stately trees makes this an exceptionally attractive site. It is on private property, contributing to one of the most unusual and scenic backyards in the state; thus visitors should respect the rights and privacy of the owners.

The bridge has a 10-foot ceiling (not including the additional 3 feet of original streambed remaining under the concrete floor) and is 50 feet wide with a 15-foot span. It had been a milk house since at least the 1890's because Shepard (1898, p. 118) cites the conversion and the spring and flume system for cooling milk. It is probably the most deluxe natural bridge in the state with door, windows, concrete slab, and cooling tank. In the past it also had a wagon road over it. The downstream end is the mouth of a hanging valley which debouches into a steep-walled gorge. A hundred feet north of the mouth is a spring which flows from a cave in the gorge wall. All of these features are developed in the Burlington Limestone.

The origin is identical to that of most of the natural bridges and tunnels in the state. The southeast-draining valley which now uses it formerly drained through a saddle on the south side of the bridge and entered the James River Valley 0.25 mile south of its present point of entry. The stream was captured at the bridge via a cave system and diverted into the present valley beneath the bridge. The chasm at the mouth of the bridge suggests the shell of a large sinkhole or a collapsed cave. This is not an easy bridge to photograph; I would like to have it in *my* backyard!

286. CASSVILLE NATURAL BRIDGE

Barry County, 6 miles southeast of Cassville, in SE¼ SW¼ NE¼ sec. 18, T. 22 N., R. 26 W., Eagle Rock 7½-minute Quadrangle.

Cassville Natural Bridge (fig. 130) has long been popular as evidenced by its occupancy prior to the advent of the white man. This shelter, the object of an archaeological excavation (Adams, 1950, p. 36-50), yielded remains of an adult skeleton, pottery shards, scrapers, awls, fishhooks, spoons, drills, projectile points, and a stick and grass bed.

The bridge has a span of 50 feet with a 30-foot ceiling at its lower end, constricting to a 25-foot span and 15-foot ceiling at its upper end. It is 160 feet long and the roof is approximately 10 feet thick. Slabs of St. Joe limestone have tumbled from the roof on the southwest side to form a shelf on which prehistoric occupants once lived 5 to 8 feet above the streambed. Although they escaped some of the modern headaches, flooding and falling ceilings could well have created maintenance and health problems.

Obviously the stream now flowing under the bridge originally flowed on the southwest side of the bridge on a bed about 25 feet higher than the present channel. The stream discovered a cave system on the left side of its valley and took the underground route.

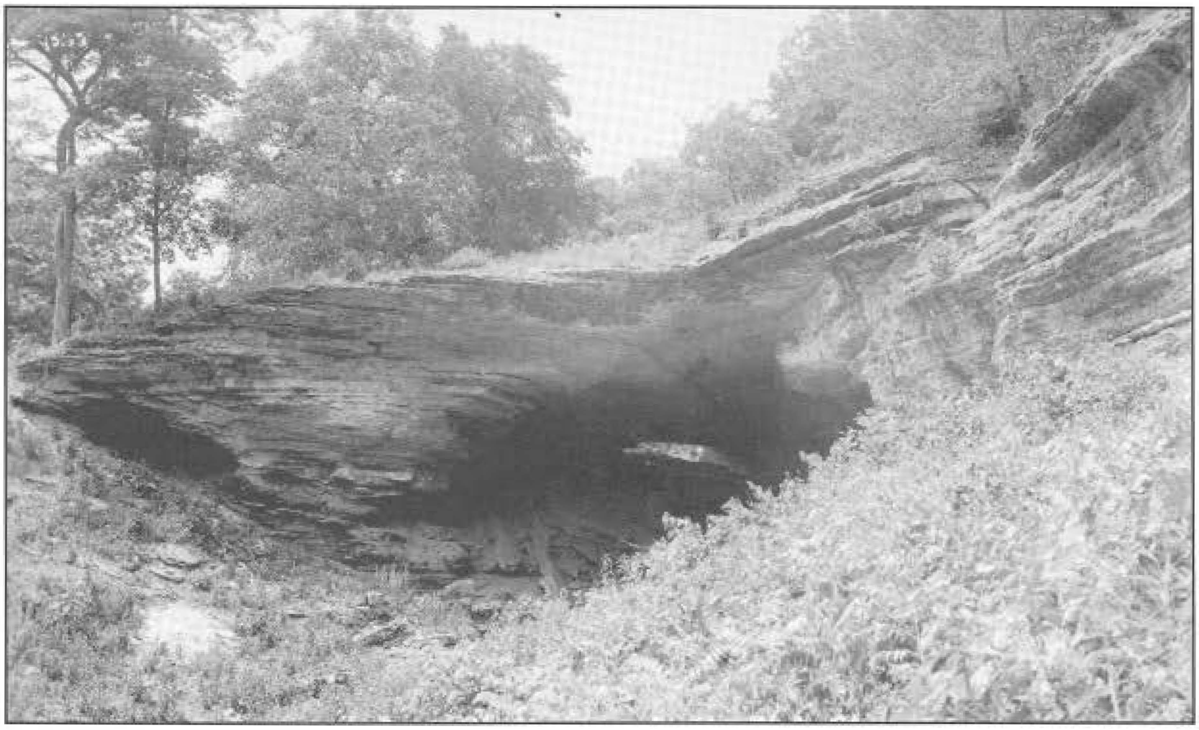


Figure 130

Cassville Natural Bridge. Photo from E.L. Clark's manuscript on geology of the Cassville Quadrangle, 1941.

The bridge was reached by the following route: From the junction of Missouri Highways 76 and 86, southeast of Cassville, drive south 3.65 miles on Highway 86 and pull into a forest trail entrance on the left. Mark Twain National Forest was entered at 3.45 miles.

Park car and walk approximately 0.1 mile to a fork in the trail. Take the left fork and follow the high-clearance vehicle trail for 0.5 mile to the natural bridge in the valley of Natural Bridge Hollow. The bridge area is rampant with poison ivy!

The topographic map shows the sharp contrast between the rugged Ozark topography of the southeastern part of the quadrangle, and the northwestern part which I consider to be outside the Ozarks. If this classification is accepted, the Ozarks are entered about a mile south of the Highway 86 and 76 junction as the highway drops down the Eureka Springs escarpment which trends northeast across the quadrangle.

287. UNITY VILLAGE NATURAL BRIDGE

(Description by Richard J. Gentile*)

Jackson County, in Unity Village, 0.3 mile northwest of Colborn Road bridge over Missouri Pacific tracks, in SW¼ NW¼ NW¼ SE¼ sec. 25, T. 48 N., R. 32 W., Lees Summit 7½-minute Quadrangle.

In 1845, Alfred S. Waugh, Irish artist and sculptor, recorded a visit to this natural bridge (fig. 131) as follows (McDermott, 1950, p. 112-114):

"Our route from Independence lay in a southerly direction along the state road to Harrisonville, for more than nine miles, until we came to the farm of the Rev. Robert Sloan, whose house stands within a few hundred yards of the object of our pursuit. Here we tied our horses, and crossing his lot under the direc-

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*Professor of Geology, University of Missouri-Kansas City

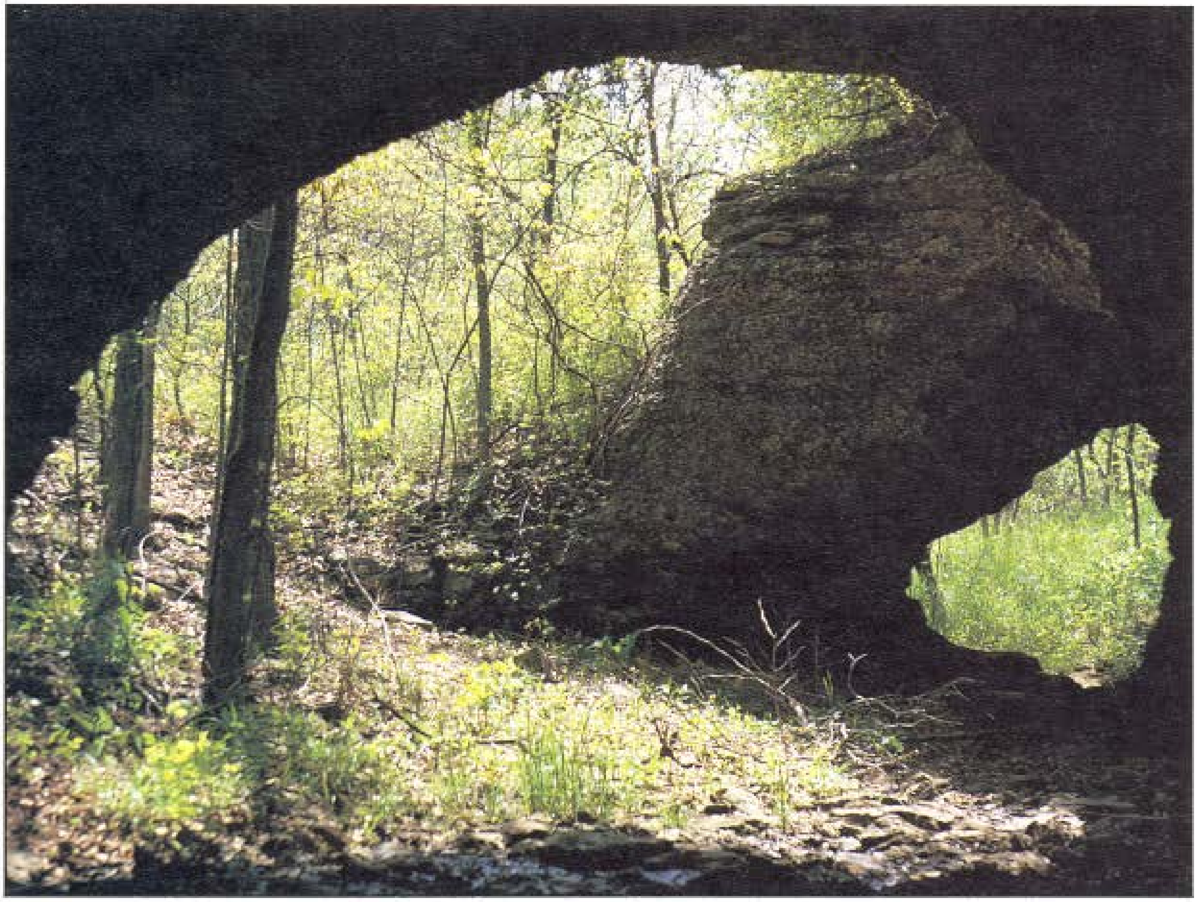


Figure 131

Unity Village Natural Bridge near Kansas City. Photo by Jerry D. Vineyard.

tion of his son, soon came to a ravine deeply shaded with hickory, hazel bushes, and sumac. Through this we descended to the dry bed of the creek (Cedar Creek) and pursuing our way along its rough channel suddenly found ourselves standing at the entrance of a low arched cavern of compact limestone of some fifty feet wide and about twelve to fourteen feet high; almost forming an equilateral triangle, and bearing the same proportions throughout its entire length—a distance of about fifty yards or so. I was very much pleased with the effect of light produced by the sunshine. As we stood at the west or lower entrance an exceeding fine effect, resembling that produced by the sun streaming through a stained glass window in some gothic cloister, attracted our attention by its monastic appearance. The opening in the extreme end was shaded by foliage, through whose partly colored leaves the sun came into the cavern and mocked the ingenuity of man by the beauty of its many tinted rays. A wide gap in the roof of the cavern, near its eastern extremity, admitted a full flood of light from the north and divided the interior into rich masses of light and shade, and affording to the artist one of the most charming studies that can well be imagined.

"This freak of nature is formed by two huge blocks of limestone, here and there encrusted with carbonate of lime in small stalactites very much resembling broccoli. About the center of the roof, a fissure, varying from half to five or six inches, completely divided it into two distinct masses, whose rough uneven surfaces, in many places, give indication of decay; and

whole strata seem ready to add their most prominent parts to the broken rugged floor, whose present elevation has, no doubt, been caused by the falling of detached pieces at different periods. As we stood now at the upper entrance and looked down to the western we again encountered another charming effect as we did when we first looked through the cavern. The mouth was shaded with foliage presenting the same illusion of stained glass as in the eastern termination. Toward the east a large gap is formed on the north side of about a dozen yards in the interior sufficiently distinct for every purpose of exploration. Beyond this the arch is again complete, and the stream, when there is water in the creek, enters by a sharp angle in the ravine and falls over a ledge of rocks into a basin formed by its own impetuosity. Within this last named arch large fragments of the roof and wall have fallen down, leaving the south side almost perpendicular. Having sat down on a mass of flat rock, I made a sketch of the interior, as far as the eye could take in the view at a glance, then turning to the right, made another introducing the figure of my friend Sam Lucas, quietly reposing at the entrance in order to give the relative proportions of the scene. After enjoying the refreshing coolness of this secluded retreat for a while, we once more emerged into the upper air and beheld a fine undulating country on the borders of a prairie, finely diversified with clumps of trees, and mantled over with a most luxurious vegetation. A broad road, wide enough to admit two wagons abreast, conducts to an elevated ground finely timbered, over which the traveller might pass and repass, without being aware of the existence of a bridge of any sort in the vicinity, so concealed are its sides by trees, whose tops, just rising a few feet above the ravine and looking so much like brushwood, entirely prevents the passerby from detecting the presence of such a specimen of Nature's own architecture.

"I now made a sketch of the road across the bridge with the accompaniments of surrounding scenery and then returned with my friend to the spot where I had made the first sketch. Our ride having furnished us with most excellent sauce to the creature comforts contained within our saddle bags, we made a very hearty dinner, after which we lighted our cigars, mounted our steeds, and returned to town well pleased with the days excursion."

The passageway is 125 feet long, 25 feet wide, and 8 feet high at the upper end, and enlarges to 12 feet high by 40 feet wide at the lower (northeast) end.

The roof, which is 5 to 6 feet thick, supported an old wagon road, as discussed by Waugh, but an 18-foot segment of it collapsed near the upper end to create the gap he mentioned.

A small northeast-flowing tributary to Little Cedar Creek excavated the bridge by enlarging a conspicuous joint trending N 45° E in the Bethany Falls Limestone Member of the Swope Formation, Kansas City Group, Pennsylvanian System. As the stream was eroding its channel deeper, its course was apparently diverted a few feet to follow the trend of fractures. Subsequent erosion along the joints combined with the collapse of blocks of limestone has developed the structure to its present dimensions.

Because this bridge is on privately owned property, the courtesies of requesting visitation permission should be observed.

288. CAVE SPRING "NATURAL BRIDGE"

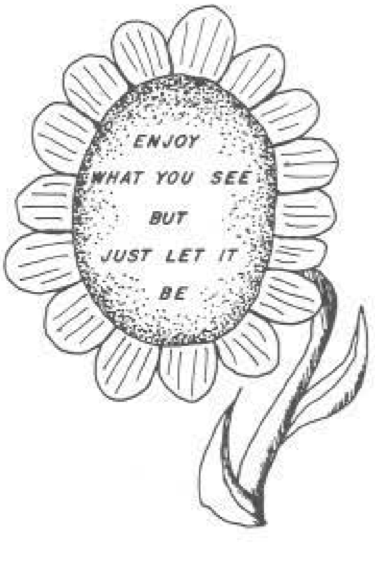
Greene County, 4 miles northwest of Willard, on west side of Highway AC, in community of Cave Spring, in SE¼ SW¼ SE¼ sec. 4, T. 30 N., R. 23 W., Willard 7½-minute Quadrangle.

Campbell (1874, p. 218) described the town of Cave Spring in the early 1870's as follows:

"...settled by an enterprising, intelligent people, has 1 church — Presbyterian, valued at $3,750 — a public school well attended, a music school, 1 drug and 2 general stores, 3 blacksmith shops, and about 150 inhabitants. A beautiful spring bursts from rocky fissures to disappear under a "natural bridge" and again emerge in full tide clear as a crystal."

The music school and blacksmith shops are gone, but the spring and a well-preserved historic Presbyterian church remain. The spring first emerges as the stream in the bottom of a miniature canyon about 30 feet long and 8 to 10 feet wide. It then disappears and flows for some 30 feet under the "natural bridge" described above to reappear in a walled basin from which it is piped for a water supply. In a strict sense this site does not contain a natural bridge. The stream fills all of the channel and a very small-scale version of a spring system can be seen here exposed by a collapsed cave roof upstream from the mouth. Remember that many of the springs in karst areas are breached water-filled cave systems. In this case, the system is breached, not only at the final outlet as is common, but also upstream from it.

Because of its name, Cave Spring has lured speleologists to this corner of Greene County. No penetrable cave opening exists, and the water-filled channel is too small for human entry. The visitor should not be completely disappointed because the Cave Spring community is a historic one. The upper spring is on property of the Mount Zion Presbyterian Church, founded in 1839 at a brush arbor near the spring, then occupying a log cabin, followed by today's church built in 1869. This frame church is attractive and well preserved. It also was reportedly the mother church for one Congregational and two Presbyterian churches.



The spring, which is shown on the Willard Quadrangle, is south of the church, west of Highway AC, and north of the road to Pearl. It is in the Burlington Limestone and, as is obvious at the upper exposure in the small canyon, is controlled locally by a southwest-trending joint system. Its flow is not great, but reportedly it did not go dry in the droughts of the 1930's and 1950's and was a source of water for less fortunate neighbors. King David would have liked this Mount Zion locale for a second residence!

289. ROCK BRIDGE MEMORIAL STATE PARK

Boone County, 4 miles south of Columbia, on Highway N, in W½ SW¼ NW¼ sec. 7, T. 47 N., R. 12 W., Ashland 7½-minute Quadrangle.

An understanding of the geologic features in Rock Bridge Memorial State Park requires a birdseye view of the area (fig. 132) because the natural bridge-cave-sinkhole system represents a single major cave perforated and partly destroyed by erosion and weathering. The natural bridge represents a remnant of the cave roof, the chasm between it and the upstream cave exists where the roof collapsed, and the Devils Icebox is a sinkhole "windowlight" into the cave system. All of these features are developed in the Burlington Limestone, the same limestone which forms The Pinnacles north of Columbia and the Devils Backbone southeast of Columbia. Limestone from this formation also was used in making the columns at the University of Missouri-Columbia as well as those preserved from the Old Courthouse north of Broadway in Columbia.

The visit should start with Rock Bridge (fig. 133) a feature which might more appropriately be called a natural tunnel were its name not well established by usage and tradition. Rock Bridge has a 15 foot ceiling, is 150 feet long, and is from 50 to 75 feet wide. The width is variable because the tunnel is actually cruciform, reminiscent of a stone chapel in floor plan. The main tunnel forms the nave and apse and an interesting cave system forms the transept or arms of the cross, thus causing a widening out of the tunnel. Solution niches and pockets in the wall add an atmosphere of the

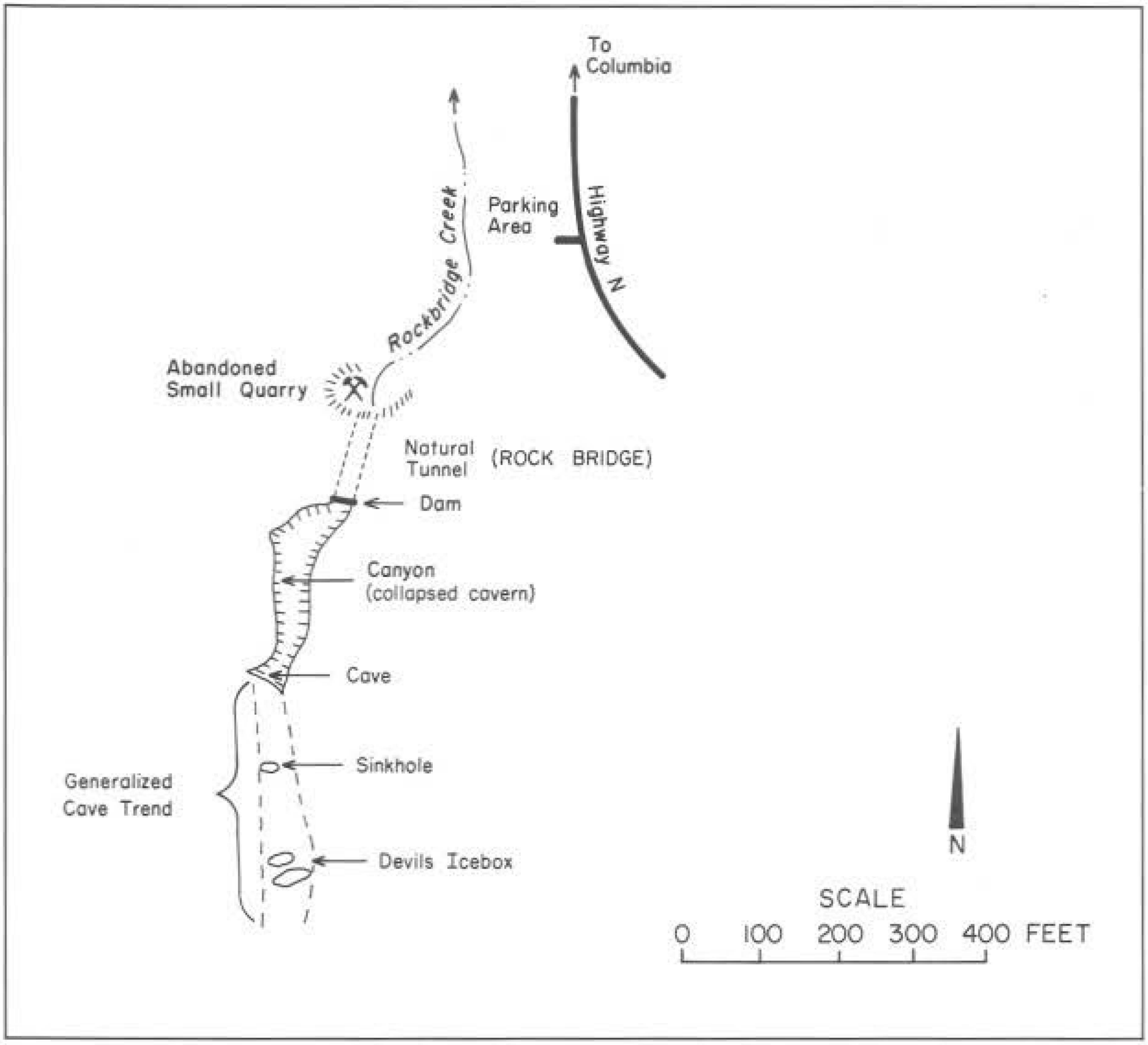

To Columbia
Parking Area
Highway N
Rockbridge Creek
Abandoned Small Quarry
Natural Tunnel
(ROCK BRIDGE)
Dam
Canyon (collapsed cavern)
Cave
Generalized Cave Trend
Sinkhole
Devils Icebox
N
SCALE
0 100 200 300 400 FEET

Figure 132

Sketch map showing relationship between the caves, stream, and natural tunnel at Rock Bridge Memorial State Park near Columbia. (Modified from Bretz, 1956, fig. 137).

Roman catacombs and one may find himself checking them for bones of the Faithful.

Bretz (1956, p. 280-286) has given an excellent description of this tunnel and the side caverns associated with it as well as the other features in the park. The upper end of the tunnel is crossed by a low dam and, as a result, the north or downstream end is the most photogenic. A long-abandoned quarry at the edge of this north entrance in the bluff wall may have provided stone for the dam.

The short canyon upstream from Rock Bridge represents an area where the cave roof collapsed and its upstream terminus is the mouth of a cave once called Connor's Cave but is thought of today as a part of Devils Icebox. The Devils Icebox is but one of the several sinkholes in the area which form a surface connection with the cave. Devils Icebox has been explored for a total passage length of more than 30,000 feet generally southeast from the canyon-Devils Icebox area. The surface expressions of its

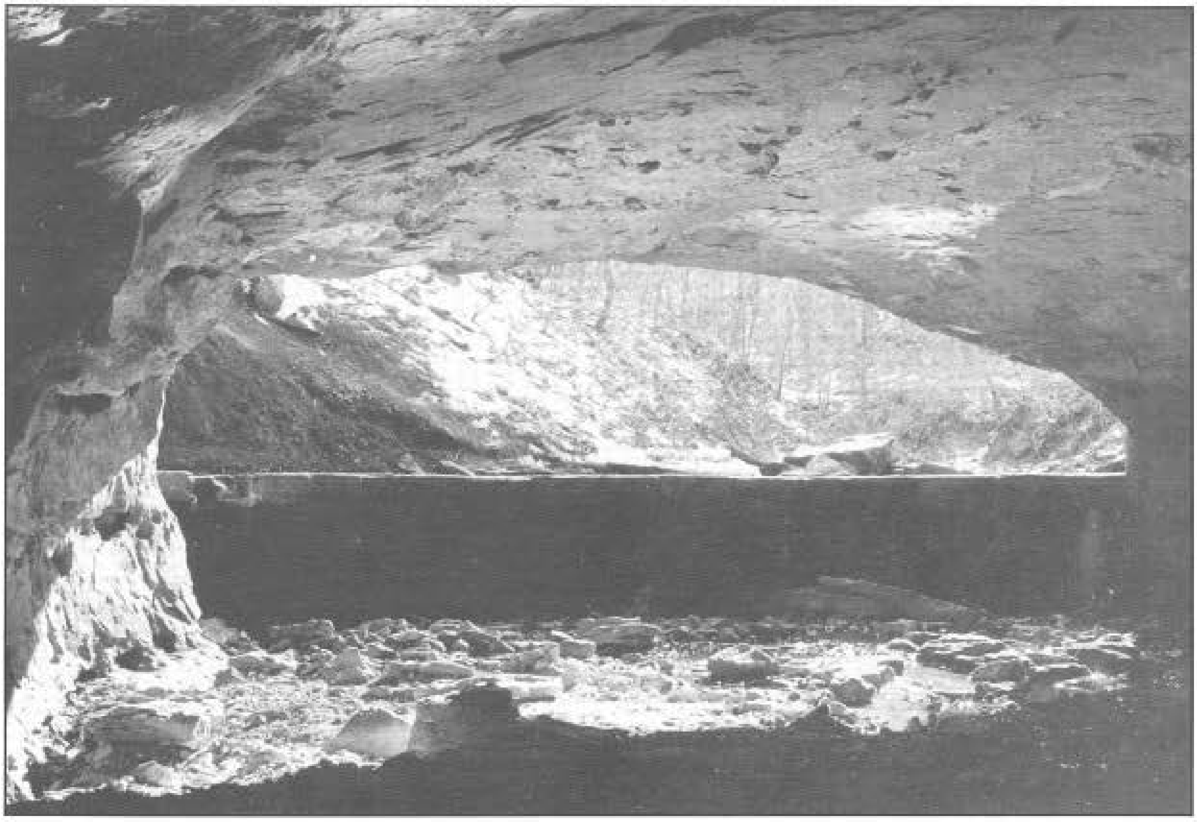


Figure 133

Rock Bridge, in Boone County, might more appropriately be called a natural tunnel. It has a 15 foot ceiling, is 150 feet long, and is from 50 to 75 feet wide. Photo by Paul A. Johnson.

original extent before the lower end was partly destroyed indicate that this may be but a small part of the total extent of the Devils Icebox.

Weaver (1959, p. 5-6) describes the first recorded exploration of the cave in 1924 via the Devils Icebox entrance. This was a 24-hour expedition by Mr. Yates and his son who explored for an estimated 7 miles — a figure which Weaver states *"...has never been proved, nor disproved."* According to Weaver, *"Between the years of 1870 and 1945 the cave saw a great deal of activity. A leather tannery, a paper mill, and a brewery have all operated beneath the canopy of its inspiring rock bridge."* He also says: *"Another individual who dreamed of making the area into a resort at this time (between 1918 and 1925) had a dance floor and merry-go-round installed. People came from miles around to dance, drink, and enjoy themselves. Story has it that one evening while people were square dancing at the base of the 'Rockbridge' two intoxicated fellows shoved a car off the lip of the bridge. The car took the 100 foot plunge and fell close to the dance floor. A few more feet could have meant death for dozens of people."*

Rock Bridge Memorial State Park owes its existence as a public area to the efforts of Professor Lewis Stoerker of the University of Missouri-Columbia faculty who initiated the purchase of the land for public use as a memorial to his 9-year old daughter Carol who was killed when struck by an auto. Others joined in his efforts and contributed to provide a memorial to the daughter who was a lover of the out-of-doors. It was dedicated by Governor Christopher Bond as a state park on the 50th anniversary of the State Park Board.

The Rock Bridge area represents one of the most compact, varied, and easily accessible combination of karst features in the state and a thorough system of boardwalks makes the tour chiggerless with a minimum of walking but a bit of climbing for those going to the Devils Icebox or to the top of Rock Bridge. The area to the south and southeast of the park in the vicinity of Pierpoint is saturated with sinkholes.

290. SELMORE NATURAL BRIDGE

Christian County, 2 miles south of Ozark and 1.5 miles northeast of Selmore, on valley wall of Elk Valley, in SE¼ SW¼ SE¼ SE¼ NE¼ sec. 3, T. 26 N., R. 21 W., Selmore 7½-minute Quadrangle.

Most Missouri natural bridges or tunnels either span stream valleys or are in the faces of bluffs, habits of habitat which aid the hunter in tracking them. The Selmore Bridge seemed almost out of place, for it interrupts a gentle slope and popped up with no warning. The slope is to the northwest between east- and north-draining forks of Elk Valley. The bridge separates a sinkhole on the south which is about 8 feet deep and 50 yards in diameter from an indentation on the slope to the north. These relations suggest that the bridge is a remnant of a collapsed cave system and that the indentation is, like the sink, a deroofed part of the cavern near the portal area.

This Burlington Limestone bridge has a span of 15 feet, a maximum ceiling height of slightly under 5 feet, a 3-foot-thick roof, and a width of 10 feet. It has served as a wagon trail bridge and thus justified its existence by utilitarian as well as esthetic contributions. A vertical fracture cuts the arch near the apex. This fracture trends due north, the same direction as the sinkhole bridge floor, suggesting that the original cave system was developed along a similarly oriented fracture or fracture system.

Photography would be best shooting north in the winter when foliage is less of a problem. A shallow cave and wet-weather spring about 200 yards to the south at the head of a west-draining tributary tempt a side trip.

The bridge could be reached by several routes. Drive north from Selmore on the blacktop (old Highway 65). Half a mile north of the Selmore Cemetery, turn right (east) onto a gravel road; follow this road for 1.1 miles and park halfway up the hill on the left side where a lane leads to both the right and left. The left lane was walked past an old homestead and the section line fence was followed north along a cowpath on the west side. This route leads to a center section fence west for a bit less than 0.5 mile north of the abandoned homestead. Follow the center section fence west for a bit less than 0.5 mile to the north rim of the shallow sinkhole.

Another route is to take the blacktop to the entrance to Elk Valley Estates, 1.2 miles north of Selmore Cemetery, or 1.75 miles south of Highway 14 at Ozark (this blacktop is also a southern projection of Business Route 65). One could follow the Elk Valley Estates drive 0.25 mile south and a bit over 0.25 mile east to a farmhouse very near the center of the section. From the farmyard, the aforementioned center section fence could be followed east to the sinkhole.

The bridge is small, but very symmetrical and one is amply rewarded by an early morning walk.

291. MILL STREET (STEURY) NATURAL BRIDGE

Greene County, in eastern Springfield, 0.5 mile east of Hickory Hills Country Club, in SW¼ NE¼ NW¼ NE¼ sec. 22, T. 29 N., R. 21 W., Galloway 7½-minute Quadrangle.

Mill Street Natural Bridge was not visited. A photograph of it is on the cover of the *Ozark Caver* (July-August 1971) and it is described by Longwell (1971, p. 7). This is the same natural bridge described by Shepard (1898, p. 117-118) as the "Storey Farm," about 4 miles east of Springfield. According to C. Helmer Turner (1959), this was the Steury Farm and the location is that given above as contrasted with Longwell's location of NW¼ NW¼ NE¼ NE¼ sec. 22. The two locations are

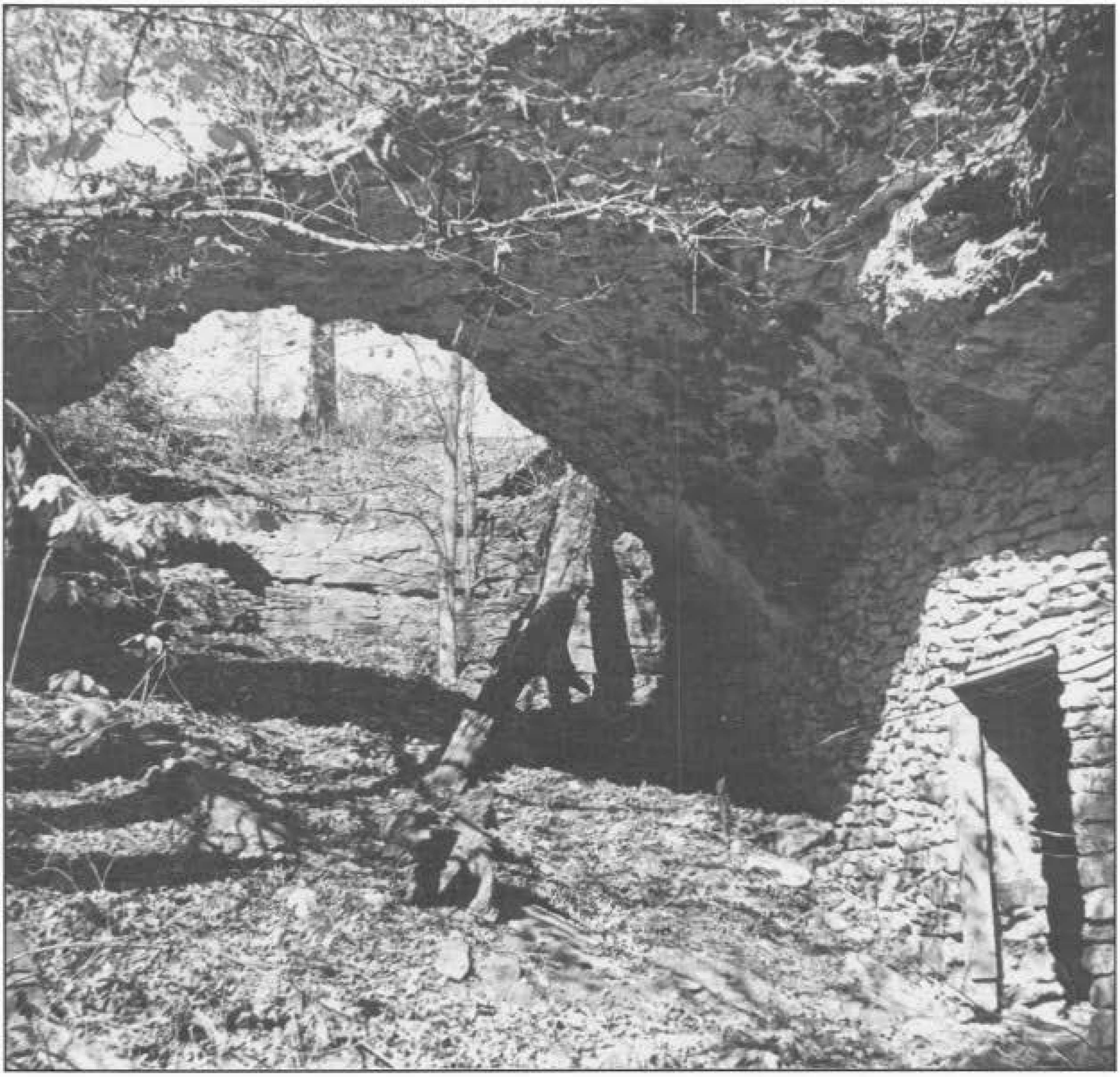


Figure 134

Mill Street Natural Bridge and entrance to Mill Street Cave. Photo by R.L. Taylor.

relatively close to one another and Shepard describes the walling of the cave system to make a milk house with an underground passage leading to the dwelling. Hayes (1972) confirmed Shepard's and Turner's location by checking the abstract which shows that John Steury owned nearly all of the quarter-quarter section designated.

292. STONEBRIDGE (MOBLEY NATURAL BRIDGE AND SPRINGS)

Greene County, 5 miles northeast of Halltown, in SW¼ NW¼ NW¼ NE¼ sec. 15, T. 29 N., R. 24 W., Halltown NE 7½-minute Quadrangle.

This bridge was a pleasant surprise! The day was hot and the attitude "one of those dinky little natural arches, but I'd better check it." As anticipated, the arch is small, but it is part of a tastefully developed spring-cave-private park system in a cool wooded valley which was left with reluctance.

The site was reached via Missouri Highways 266 and T between Springfield and Halltown. At the junction of 266 and T, turn north on T and follow it for 1.3 miles from the junction to a road running west (to the left). Turn onto this road and follow it for 2.8 miles to a point where it terminates at a private road, a few yards west of a house on the north side. At the termination, go southwest along a trail for 880 feet into a valley. At this point the natural bridge is visible to the left where it spans a baby canyon terminating precipitously at the trail.

The baby canyon is obviously a collapsed cavern and the bridge is a remnant of the roof. The rock composing the bridge is in the form of layers of chert and limestone of the Elsey Formation, neatly alternating, to resemble the work of a skilled stonemason. The bridge has a span of 15 feet at the base, a ceiling height of 7 feet, and a roof that is 9 feet thick. It is but 3 to 4 feet wide and the visitor a few thousand years hence may find it removed by erosion!

The bridge overlooks a streamlet which flows from the base of a bluff a few yards upstream. Between the spring and the bridge, a cave with a 25-foot wide and 6-foot high entrance interrupts the bluff line. Although there has been extensive masonry work below the spring, the natural setting has been enhanced by the work of man. The masonry work has aged and blends in with the masonry-like appearance of the bridge to create a delightful little canyon park.

An unoccupied stone building on the trail a few yards beyond the bridge and a cabin farther downstream attest to the past popularity of the locale and induced daydreams of a perfect retirement Shangri-La.

293. BAY BRANCH NATURAL BRIDGE

Shannon County, 6 miles north of Eminence, on the south side of Current River, in SE¼ SW¼ SW¼ NE¼ north square mile of sec. 2, T. 29 N., R. 4 W., Eminence 7½-minute Quadrangle.

As an accent betrays one's original language, so vestiges of original structure betray the origin of a natural arch. The small arch at the mouth of Bay Branch was formed by extensive collapse of a cave roof behind the entrance, separating the entrance from the rest of the cave. Both the severed cave and an overhanging remnant of the original cave roof remain, showing unmistakable lineage.

The arch spans 16 feet, and there is 7 feet of clearance beneath it. The width is about 20 feet. The small remnant cave is about 100 feet long.

Bay Branch Natural Arch can be most easily reached from the Current River, by a 0.25-mile walk from the sharp bend and bluff at the mouth of Bay Branch. For those using a topographic map, a ridge road leads about 4 miles from Highway 19 to the river. The arch is in a hillside on the east side of Bay Branch.

294. CLIFFDALE HOLLOW NATURAL BRIDGE

Jefferson County, 7 miles southeast of Festus, in Cliffdale Hollow, NE¼ SE¼ SW¼ NW¼ sec. 27, T. 40 N., R. 6 E., Selma 7½-minute Quadrangle.

This bridge is reminiscent of deserts in the West where wind sandblasting has been a factor in carving the spectacular natural arches. Windblown sand was not the sculpting tool at Cliffdale, but the fact that the bridge is in sandstone with a classic arch design makes it a bit unusual as contrasted with its limestone or dolomite kin which are most common in Missouri.

Cliffdale Hollow is aptly named. At the bridge site, steep cliffs of the St. Peter Sandstone make entry into the canyon difficult from the north but, fortunately, a tributary which enters the canyon at the mouth of the bridge serves both as a navigational guide and entrance.

A skilled salami slicer produces circular slices by cutting at right angles to the longitudinal axis whereas sloppy oblique slicing results in the elliptical cross-section of analytical geometry. The entrances to Cliffdale Bridge have spans greater than the diameter of the tunnel because they follow fractures (slices) which are not at right angles to the longitudinal axis of the tunnel (salami). The downstream entrance has a span of 100 feet, the upstream one, a span of 50 feet. The angular relationship between portals and tunnel results in the tunnel being 100 feet long on the northwest side and only 30 feet long on the opposite side. The upstream portal, although smaller, is the more photogenic. An afternoon photo toward the northeast would be the most timely if direct sunlight is desired.

Some 75 feet upstream is a wet-weather waterfall with a drop of about 13 feet. The canyon between the fall and the bridge, may be the walls of a once-longer tunnel. The roof of the bridge is 15 to 20 feet thick and the ceiling height is within the same range.

The origin of this natural bridge is not obvious. Was it produced by dissolving of the dolomite visible in the valley floor immediately underneath the sandstone? Such action could have resulted in collapse of the sandstone roof with a canyon where it was complete and the bridge where it was partial. Enlargement of the tunnel is also being abetted by weathering (freeze-thaw expansion) which is producing spalling of the sandstone in the walls and roof of the bridge. No evidence of a collapsed cave system in the underlying dolomite was seen and speculation is a necessity here.

Vineyard (1971, p. 72-77) postulates erosion of the weakly cemented and permeable contact zone between the St. Peter and underlying dolomite followed by local collapse of the overlying St. Peter.

The bridge was reached via the following route:

Miles	
0.0	*I-55 and U.S. Highway 61 interchange 5 miles south of Festus. Go southeast on Highway 61.*
0.2	*Grindstone Hill Roadside Park. Overhanging cliffs of St. Peter Sandstone.*
0.3	*Turn left (north) off 61 onto gravel road.*
1.0	*Turn right into farmyard. Obtain entrance permission at house and follow first ravine south of house into Cliffdale Hollow. Ravine joins canyon at lower entrance to natural bridge.*

295. GRAVOIS MILLS NATURAL BRIDGE

Morgan County, 3 miles northwest of Gravois Mills, in south bluff of Rocky Fork Creek, center north line sec. 12, T. 41 N., R. 18 W., shown on Gravois Mills 7½-minute Quadrangle.

This might more appropriately be called an arch rather than a bridge but such usage would require sufficient courage to debate the terminology used on the Gravois Mills Quadrangle and a wooden sign (1972) on a nearby tree advertising "Natural Bridge For Sale." Regardless of the name, it is attractive, photogenic, near a major highway, and but a few yards from and visible from a gravel road.

To reach it, turn southwest off Highway 5 onto Highway J, 2 miles northwest of Gravois Mills. After traveling 0.3 mile on J, bear right (northwest) onto a county road and follow it for 0.5 mile farther to where the road turns right. Park before turning at the corner and walk to the bridge to the left (south) in the bluff.

The bridge has a span of 25 feet and a maximum roof height of 16 feet. The roof is a minimum of 3.5 feet thick and 4 feet wide — thus the argument for calling it an arch, or at the most, a footbridge.

This bridge appears to be the last remnant of a cave roof. Jointing in the Gasconade Dolomite undoubtedly determined its outline as viewed from above as well as the orientation of the steep and short ravine it spans.

296. TUNNEL BLUFF NATURAL BRIDGE

Ripley County, in east bluff Current River midway between Doniphan and Van Buren, opposite Hawes Recreation Area, near north line sec. 22, T. 25 N., R. 1 E., Grandin SW 7½-minute Quadrangle.

This site was not visited; it is most easily reached by boat and best seen in the winter or early spring. Although it is in "Tunnel Bluff" it is reported to be more of a bridge than tunnel. The bridge is approximately due east of the south tip of the island opposite Hawes Recreation Area close to where an old channel of the Current leaves the bluff to rejoin the modern channel. Reportedly the bridge is about 50 feet above the floodplain and has a span "big enough to drive a truck through."

The area may be reached via Highway C which connects Highway 60 and 160 west of Van Buren and Doniphan, respectively. Forest Route 3142 goes east from "C" to Hawes Recreation Area.

We are indebted to Bill Royce, editor and publisher of the *Ozark Graphic*, Doniphan, for information on this site.

297. ST. CLAIR NATURAL BRIDGE (?)

Franklin County, near Highway WW, 0.5 mile northwest of I-44 or 2 miles west of St. Clair, Stanton 7½-minute Quadrangle.

Swallow (1866, p. 40) describes a natural bridge in the northeast corner of sec. 33, T. 42 N., R. 1 W. and also shows the bridge at the same location on an accompanying map. Furthermore, he describes the bridge as being composed of sandstone. The location he cites is one where the Roubidoux sandstone crops out and the fact that his written description and his map both show the natural bridge suggests very strongly that his location must have been fairly accurate. The bridge could not be found and possibly it may have been destroyed or covered with refuse from the open pit iron ore and "sulfur" (pyrites) mine nearby. Those who live in the area have no memory of such a bridge and the search was abandoned after a considerable amount of exploration and interrogation.

298. CEDAR BLUFF NATURAL BRIDGE

Webster County, 5 miles northeast of Niangua, at Cedar Bluff, on northwest side of Cantrell Creek, in SW¼ SE¼ NE¼ SE¼ sec. 12, T. 31 N., R. 17 W., Rader 7½-minute Quadrangle.

Cedar Bluff Natural Bridge is easily reached and on a well-known scenic bluff overlooking a long eddy which is a popular fishing stretch. The bridge is formed in thick-bedded dolomites of the Jefferson City formation. These dolomites may represent the Quarry Ledge, a popular building stone of past years from the latitude of Texas County north to the Missouri River area.

The bridge has a span of 18 feet, a maximum ceiling height of 10 feet, and a passageway length of 17 feet which is nearly doubled if the impressive 15-foot overhang on the riverside is included. The ceiling is 9 feet thick. The passageway trends N 60° E and is determined by fractures oriented in that direction. The northwest flank of the bridge owes its existence to fractures trending N 10° W. This bridge is similar to many others in having a steeply sloping floor toward the bluff face and it is not easily photographed without a wide-angle lens. The simplest photography would be looking to the southeast through the arch from the upslope side toward the valley of Cantrell Creek. Winter would be the best season for photographic contrast because of heavy vegetation along the bluff face.

Twenty yards downstream (southwest) of the bridge is a steep tributary canyon with vertical walls and huge blocks of tumbled dolomite at the lower part of the bluff. The appearance of this canyon and the dolomite debris suggest that it may also once have been the site of a natural bridge almost identical in orientation and size to the present one.

The bridge was reached by the following route:

Miles

0.0 *Turn from Highway M onto F going northeast from the town of Niangua northeast of Marshfield.*

5.3 *Cross Osage Fork of Gasconade River.*

5.6 *Bear right off Highway F.*

5.75 *Park on right-hand side of road short of low water bridge across Cantrell Creek. From this point walk upstream for about 0.25 mile along a path on the northwest bank of the eddy, following this path until the bluff rises ahead. Work up the bluff to a higher path under the overhang, watching for the natural bridge on the left. Return may be made along the same bank. Following the bluff line along the high road is recommended after heavy rains because the path along the bank is quite muddy and slippery.*

The arch is very attractive. The setting with cedars atop the dolomite bluff and overhang is restful, and the visitor will feel well rewarded after a short walk and easy climb to this popular picnic area. Allen Conrad of Sho-Me Power Corporation kindly acted as a guide to this site and to Osage Fork Natural Bridge (No. 299).

299. OSAGE FORK NATURAL BRIDGE

Webster County, 4 miles northeast of Niangua, in southeast bluff of Osage Fork, near center SW¼ NE¼ SW¼ sec. 13, T. 31 N., R. 17 W., Niangua 7½-minute Quadrangle.

Osage Fork Natural Bridge is not large and is not easy to find in the summer. It should be visited in the winter by those who can use the topographic map for navigation. It is formed in Jefferson City dolomite, and would be seen from above as penetrating the rock thumb of a mitten, the thumb being a peninsula parallel to the bluff and midway up it. Between the finger and the main bluff is a narrow canyon.

The bridge is formed along an east-west fracture system and is relatively small, being 4 to 5 feet in diameter and 7 feet in length. In the geologic past it was longer, as evidenced by its termination as a canyon trending in the same direction on the west side. This canyon is 10 feet long and was undoubtedly formed by roof collapse of a once-longer tunnel. Photography would not be particularly rewarding at this site, but the spelunker might wish to visit it because a cave is reported along the bluff upstream between this site and the junction with Cantrell Fork.

The shortest approach to this site might be from the house near the center of the east line of sec. 14, following a private lane from this house to a ford across Osage Fork about 100 yards upstream from the natural bridge. The natural bridge is at a break in the bluff with a sheer drop below it and easy climbing above it. Thus, the visitor may want to come in from above or work along the break at the top of the steep bluff.

300. HAYNIE BRANCH NATURAL BRIDGES

St. Clair County, 8 miles southwest of Collins and 0.25 mile south by slightly east of Greenwood School site, in NE¼ NW¼ NW¼ SW¼ sec. 25, T. 36 N., R. 26 W., Caplinger Mills 7½-minute Quadrangle.

As shown on figure 135, Haynie Branch Natural Bridges are twins formed by the breaching of a cave system with a remnant of the original cave terminating the complex. The bridge-cave complex is developed in Pennsylvanian sandstones which are less resistant to erosion in the lower part and which have been fractured by vertical joints running at right angles to the valley which the system spans. The system which spans the valley undoubtedly also spawned this valley because the steep-walled portion of the valley terminates at the cave, indicating that this portion of the valley represents a formerly more extensive cave system. Above the cave the valley is broad and flat where the stream flows on resistant sandstones, the

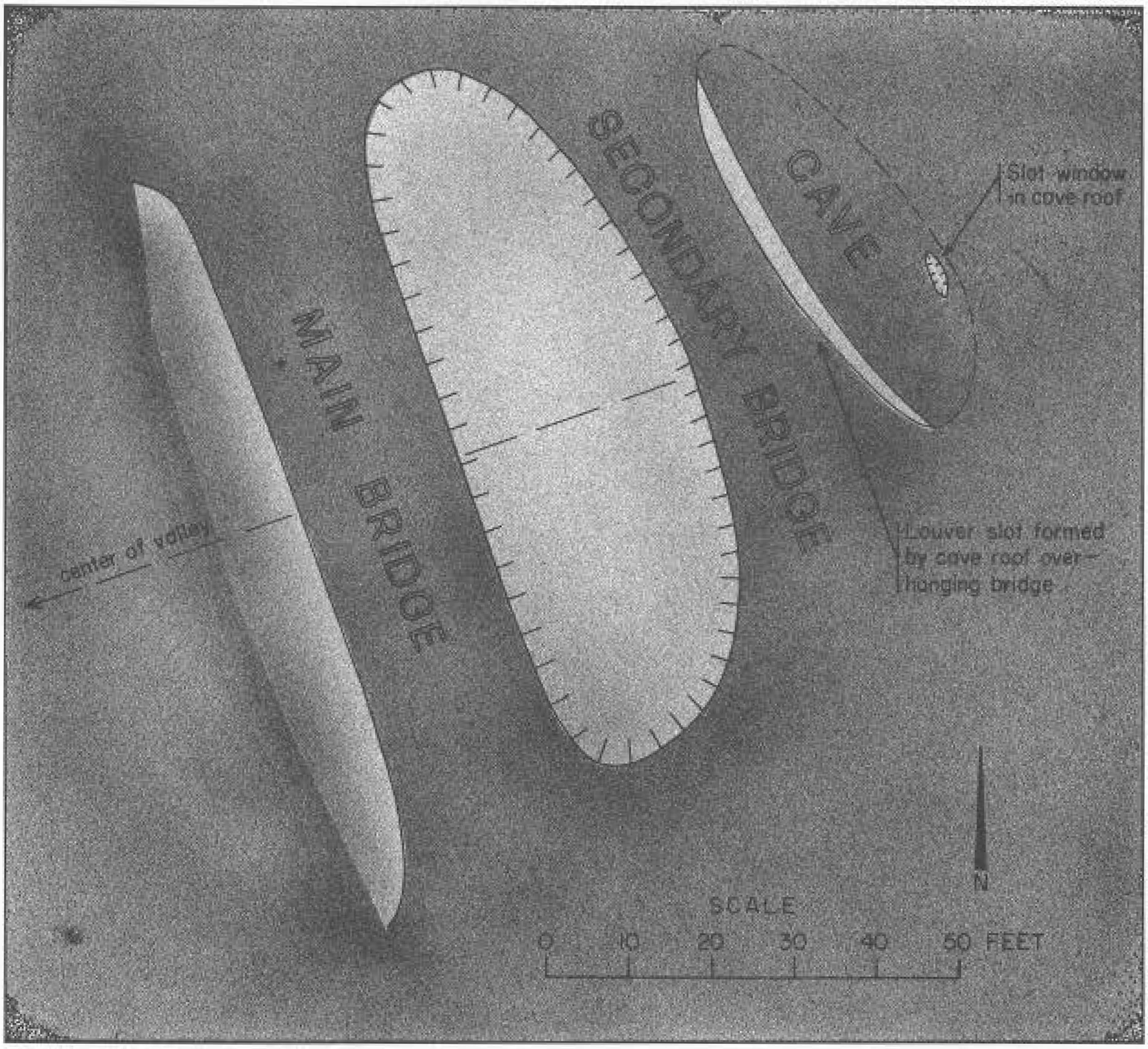

SECONDARY BRIDGE
CAVE
Slot window in cave roof
MAIN BRIDGE
center of valley
Louver slot formed by cave roof over-hanging bridge
N
SCALE
0 10 20 30 40 50 FEET

Figure 135

Haynie Branch Natural Bridges and Cave near Collins in St. Clair County.

lower part of which form the bridge decks and cave roof.

The main arch is 60 feet in span, 35 feet wide, and has a 6-foot ceiling in the center and a deck or cap 3 feet thick. It trends N 20° W, approximately at right angles to the valley, following cross-valley fractures which determined its orientation as well as that of the secondary bridge upstream. Between it and the secondary bridge is an open area representing a collapsed roof. The secondary bridge has a maximum ceiling height of 8 feet, a span of about 25 feet, and is 20 feet wide with a 4-foot thick ceiling. It is separated from the very shallow cave upstream by a slot formed by beds of the cave roof overhanging the bridge. This slot is a huge louver 25 feet long with an open space tapering to a maximum of 4 feet in the center between the top of the bridge and the ceiling of the cave roof. The cave is only about 15 feet deep and has a window-like slot in its southeastern corner which eventually will enlarge to form a third natural bridge from the cave roof.

The site was reached by the following route:

Miles

0.0 *Turn south off U.S. Highway 54 onto Highway J. This junction is 5 miles west of the junction of Highways 54 and 13.*

3.0 *Junction Highways J and W; continue southwest on J.*

4.5 *Bear right (west) off J onto dirt-gravel road.*

4.8 *Park at pullout just short of north-south section-line fence. A few yards east of the pullout is the foundation of the former Greenwood School. Walk south from this pullout along the east side of the section-line fence following a steep sandstone valley. This valley broadens to form a floodplain and intersects with a main stream coming in from the left. Follow this main stream to the intersection with a less permanent stream entering from the east, and follow this short tributary valley to the east to the natural bridges. The ridges are S 8° E from the Greenwood School foundation, a beeline distance of 0.25 mile.*

301. NATURAL BRIDGE CAVE

Dent County, 8 miles northeast of Salem, in east bluff of Meramec River, 0.8 mile south of Missouri Highway 19, in SE¼ NW¼ NE¼ SE¼ NW¼ sec. 26, T. 35 N., R. 5 W., Short Bend 7½-minute Quadrangle.

This late-entry site was not visited. Schwartz (1975) describes it as follows:

"The two entrances are in an odd-shaped outcropping about 80 feet from the Meramec River. The cave goes through the outcropping and is about 15 feet long. The two entrances are 2 feet in diameter. There are actually two natural bridges, but one is only considered a cave, and it's hardly a cave."

302. LAKEY NATURAL BRIDGE

Douglas County, 13 miles southeast of Ava, in NW¼ SE¼ sec. 8, T. 25 N., R. 14 W., Rockbridge 7½-minute Quadrangle.

This bridge (or arch) is reported to be *"68 feet long, 9 feet wide, 2 feet thick. Bridge stands 30′ from ground."*

303. HICKS SPRING NATURAL BRIDGE

Ozark County, 4 miles northeast of Dora, on west side of North Fork River, in NW¼ NW¼ sec. 2, T. 24 N., R. 11 W., Dora 7½-minute Quadrangle.

This natural bridge is reported to be 0.375 mile downstream from the confluence of Spring Creek and North Fork. No other data are available, but the huge arched spans of Twin Bridges on Missouri Highway 14, a mile upstream are exceptionally impressive artificial bridges (with an adjacent roadside picnic area).

NATURAL TUNNELS

304. ST. JAMES NATURAL TUNNEL

Phelps County, 3 miles southeast of St. James, along private lane, in SE¼ SW¼ NE¼ SW¼ sec. 27, T. 38 N., R. 6 W., Maramec Spring 7½-minute Quadrangle.

St. James Tunnel is a pleasure to man and beast — as a scenic site and as a livestock shelter which is cool in summer and relatively warm in winter. Because it is on a private lane, visitors should obtain access permission.

The tunnel is in Gasconade Dolomite and by its geometric configuration shows the influence of joints in determining the outlines of the cave. The upper entrance of the tunnel is about 15 feet high by 20 feet wide. An S-shaped passage approximately 250 feet long leads to the exit nearly twice as large as the entrance which is partly blocked by a barn. Bretz (1956, p. 380-390) considers this tunnel to be *"...but a surviving part of a larger cave which has been destroyed by the valley-making of Dry Fork."* Dake and Bridge (1923, p. 5-6) chose this tunnel as the lead-off example and describe it thoroughly in their discussion of subterranean stream piracy in the Ozarks.

Prior to capture, the small stream which follows the lane between the two gates flowed northeast over what is now a low saddle a short distance north of the tunnel entrance. The stream took a shortcut through (or was captured by) the cave now represented by the natural tunnel. Because the stream entered the subjacent cave in what was then the floor of its valley, it began to erode downward rapidly in response to the high gradient created by the more direct and much lower subsurface channel to Dry Fork; as a result, the old streambed preserved in part from the divide or saddle north of the tunnel eastward is higher than the present bed west of the divide (fig. 136).

The lower end was boarded up when the site was visited in the 1960's and livestock used it as a shelter. Bovine competition has tended to reduce its popularity with picnickers.

The bridge is reached from St. James via Missouri Highway 68 as follows:

Miles	
0.0	*Cross railroad tracks in St. James headed south on Highway 68.*
1.9	*Highway Maintenance Building on left.*
2.1	*Bear left off Highway 68 onto gravel road.*
2.8	*Where lane bears left, go straight ahead (east) through gate down private lane.*
3.05	*Park near second gate and follow small stream downstream to where it enters tunnel. Tunnel is 200 feet downstream from gate.*

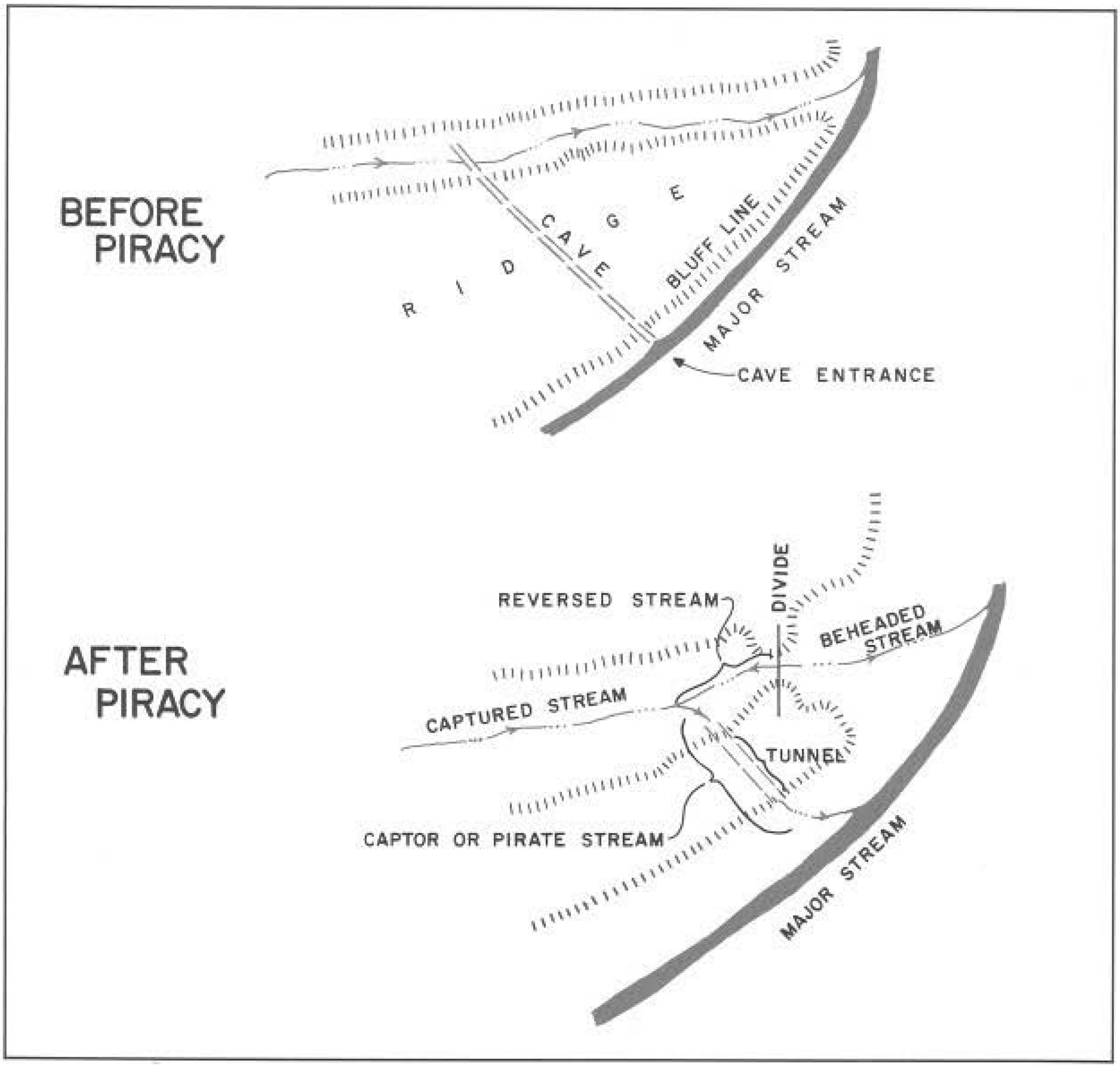

BEFORE PIRACY
RIDGE
CAVE
BLUFF LINE
MAJOR STREAM
CAVE ENTRANCE
AFTER PIRACY
REVERSED STREAM
DIVIDE
BEHEADED STREAM
CAPTURED STREAM
TUNNEL
CAPTOR OR PIRATE STREAM
MAJOR STREAM

Figure 136

Schematic diagram of subterranean piracy at St. James Natural Tunnel and Kaintuck Hollow Natural Tunnel.

Dry Fork owes its name in part to subterranean piracy. Beckman and Hinchey (1944, p. 95-96), in referring to the sources of nourishment for Maramec Spring, say:

"The source of Meramec (Maramec) Spring is thought to include portions of an area which lies to the south, west, and southwest of the spring. Asher Hollow and Brown Hollow, which have a drainage area of some twelve square miles south of the spring, are usually 'dry' creeks which carry appreciable amounts of surface runoff only at times of heavy local rainfall. The large drainage basin of Dry Fork lies to the southwest and west of Meramec Spring [sic], and it is probable that much of the rainfall on the lower portion of Dry Fork basin seeps into the ground through openings and solution crevices in the cherty dolomite bed rock of the region — thus contributing to the subsurface drainage system of the spring region."

305. KAINTUCK HOLLOW NATURAL TUNNEL

Phelps County, 5 miles southwest of Newburg. Tunnel on tributary, in SE¼ SE¼ NW¼ NE¼ sec. 16, T. 36 N., R. 9 W., Kaintuck Hollow 7½-minute Quadrangle.

Kaintuck Hollow Natural Tunnel, in Mark Twain National Forest, is open to the general public and is especially attractive because of its remote and scenic setting. Directions for reaching it are as follows:

Miles

0.0	*On Missouri Highway T bridge over Little Piney at south edge of Newburg headed south. After crossing bridge bear left, staying on Highway T.*
6.1	*Kentuck (not "Kaintuck" on sign) Hollow Baptist Church on right.*
6.3	*Turn right off Highway T onto gravel road at Mark Twain National Forest sign and follow gravel road as it bears to right into valley.*
7.0	*Walking Access Trail to left. Follow this trail past stone house foundation and concrete remains of springhouse on right. Bear right at springhouse and go to head of east-draining hollow. Proto Arch (No. 251) is 0.3 mile from springhouse in steep northeast draining tributary on the left near head of ravine.*
8.4	*(Continuing to Kaintuck Hollow Tunnel) Trail angles to left off road. May be driven in dry weather with good clearance vehicle; otherwise, follow it on foot.*
8.55	*Park here; follow main trail on foot for nearly 700 yards southeast from Kaintuck Hollow ford to mouth of tunnel which is straight ahead where trail bears to the left.*

From the trail, enter the tunnel at the mouth which is 30 feet wide and 10 feet high. The tunnel is 175 feet long and angles to the right 50 feet from the downstream entrance, trending N 45° W in the upper part and N 30° E in the lower passage. It narrows to 20 feet in span and 6 feet in ceiling height. The roof is 6 feet thick at both ends.

Dake and Bridge (1923, p. 7) described Kaintuck Hollow Tunnel and mentioned its similarity to St. James Tunnel. The two are identical, not only in origin, but also in orientation of the drainage involved in the subterranean capture; therefore, one schematic map portrays the deduced origin of both (fig. 136). Prior to capture, the wet-weather stream which flows through the tunnel flowed northeast over what is now a saddle northeast of the tunnel. The stream took a shortcut through (or was captured by) the cave now represented by the natural tunnel. Because the stream entered the subjacent cave in what was then the floor of its valley, it eroded downward rapidly in response to the high gradient created by the more direct and lower subsurface channel to Kaintuck Hollow; as a result, the old streambed preserved in part from the divide or saddle north of the tunnel is higher than the present bed west of the divide.

Erosion has destroyed part of the cave system represented by the tunnel, but small springs at the northwest entrance and due north from the tunnel further suggest karst conditions in the Gasconade Dolomite of the area. The parallelism of the northeast-trending lower part of the tunnel and the main draw draining into it suggest fracture control of the surface and subsurface drainage.

The name of Kaintuck Hollow is local dialect for "Kentucky" and one might wonder why the original dialect has not been preserved *in toto* by calling it Kaintuck "Hollah" or "Holler."

If the water is low or a high-clearance vehicle is used, the road paralleling Kaintuck Hollow could be followed northwest for an additional 2 miles to the Mill Creek Recreation Area in the north part of sec. 4. High water precluded using the ford 0.5 mile north of Natural Tunnel turnoff.

306. UNDERPASS CAVE NATURAL TUNNEL AND WATERFALL

Osage County, 3 miles southwest of Linn, in center NW¼ NE¼ NE¼ sec. 22, T. 43 N., R. 9 W. Shown as Fisher Cave on Westphalia East 7½-minute Quadrangle.

This tunnel is similar to Tunnel Cave (No. 315), 12 miles southeast, in that it is crossed by a country road and contains a vantage-point view of stream piracy. As an added attraction, Underpass boasts a surprising waterfall in a setting which is paradoxically primeval despite its nearness to the road.

Directions for reaching the tunnel are as follows:

From Linn:

Miles	
0.0	*Turn south off U.S. Highway 50 onto U.*
1.8	*Turn right (west) off Highway U.*
3.6	*Turn left (south) at T-junction.*
3.65	*Road crosses tunnel.*

From Rich Fountain:

Miles	
0.0	*Turn north off Highway E onto U.*
5.75	*Turn left (west) onto Highway DD.*
6.75	*Turn right (north) off DD onto county road.*
7.35	*Road crosses tunnel.*

The tunnel, which runs under the road at right angles, is approximately 190 feet long and has a 6- to 7-foot ceiling height. The upper or east end has a 30 foot span; the west portal is only 4 to 5 feet wide. A few yards downstream from the west portal the streambed drops as a 30-foot vertical fall flanked by steep valley walls crested with cedars (junipers).

The northwest-flowing headwaters of Loose Creek on the east side of the road were captured by subterranean piracy through this tunnel and now enter Brush Creek on the west side of the road. The east-west road, 0.05 mile north of the tunnel, crosses Loose Creek very near the divide where the direction of drainage was reversed from south to north.

The rate of growth of some cave formations is well demonstrated in this tunnel. It was visited in the summer after being completely flushed by spring rains a few months previously. Despite this scouring, the roof contained fresh straw (hollow) stalactites half an inch long. A flashlight is handy because the middle part of the curved tunnel is dark.

The ideal time for photographing the waterfall is during the rainy season in spring or fall when foliage is at a minimum. A late afternoon shot takes advantage of natural light in the narrow canyon.

Why the waterfall? The piracy short-circuit into Brush Creek resulted in the new course at the tunnel being 180 feet above the valley of Brush Creek, thus causing headward sapping which eroded a canyon terminated by a waterfall. This fall was originally at the juncture with Brush Creek and will continue to migrate eastward until the natural tunnel is destroyed by erosion in the geologic tomorrow.

307. TUNNEL DAM NATURAL TUNNEL

Camden County, 11 miles southwest of Camdenton, in N½ NW¼ sec. 19, T. 37 N., R. 17 W., Lake Niangua 7½-minute Quadrangle.

Tunnel Dam Natural Tunnel is intriguing to geologists but, unfortunately, is not particularly attractive to the layman. Fortunately, it is well enough known to lure people to the site which contains a more scenic but less publicized attraction. The tunnel goes through a very narrow ridge. The road which tops this narrow ridge dividing meander loops of the Niangua River certainly should have been called "The Narrows" but somehow escaped this most appropriate name. The view from the ridge road is spectacular, especially to the south and southwest, and is but a short drive from Camdenton (fig. 137).

According to Dake and Bridge (1923, p. 11-12), the site was surveyed in 1909 with the hope of establishing a hydroelectric plant at the tunnel utilizing the 22-foot fall of the river between the upper and lower ends of the tunnel. The tunnel was to serve as a tailrace and

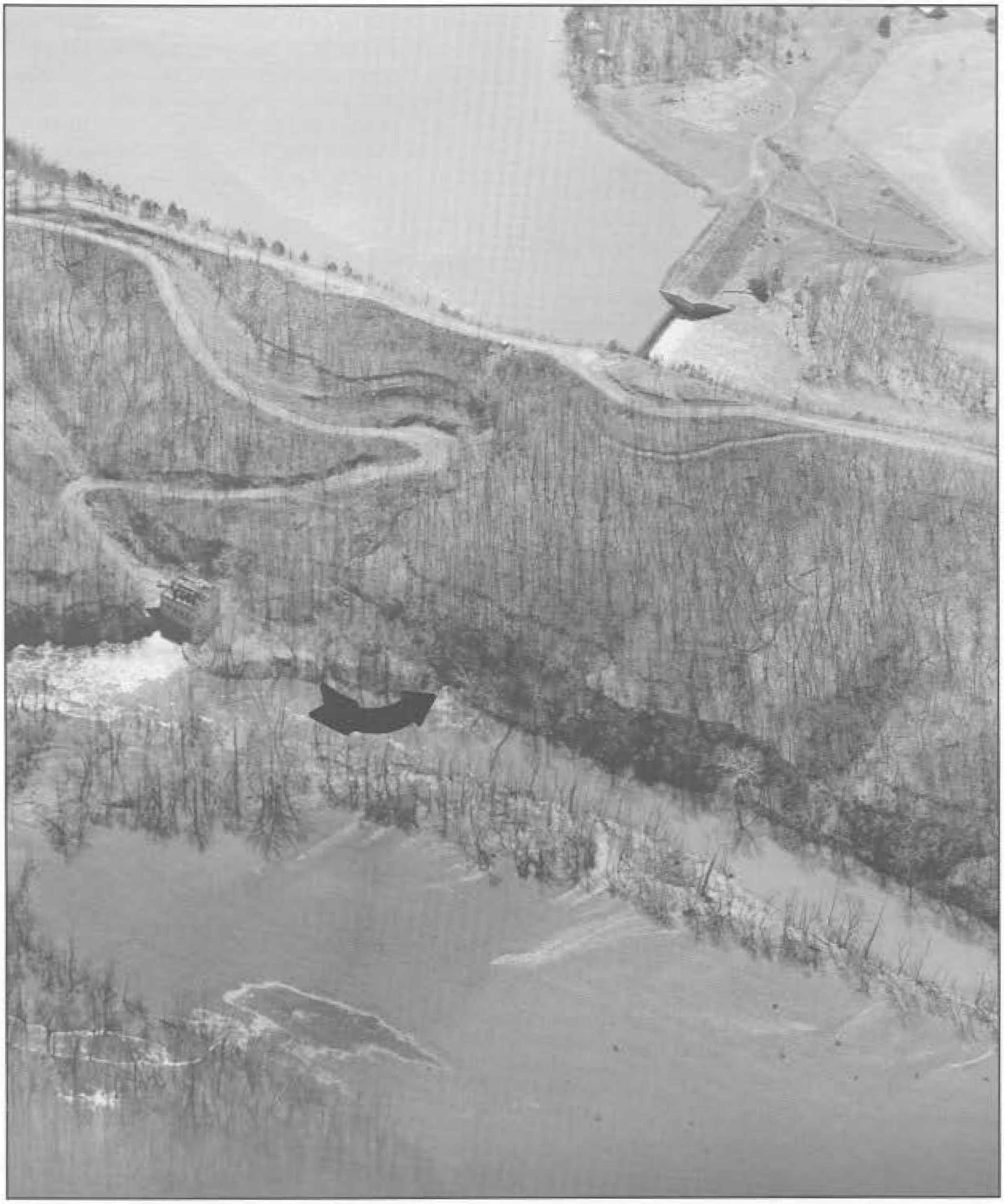


Figure 137

Tunnel Dam Natural Tunnel (upper portal) is about 75 feet below (downstream from) Tunnel Dam. The power plant is at the lower end of an excavated tunnel; the lower end of the natural tunnel is indicated by an arrow. Photo by David Rath and James H. Williams.

excavation was started to enlarge it at the upper or south end, but the project was abandoned.

The natural tunnel is about 75 feet below the dam. The entrance, in the Gunter sandstone, has been artificially enlarged to about 14 feet high by 12 feet wide. Its natural portion constricts to approximately 6 feet wide by 10 feet high a short distance inside and it is reported that it constricts still further when traced to the north. This tunnel cannot be walked and penetration must be considered a cave exploration project. Jerry D. Vineyard of the Missouri Department of Natural Resources, Division of Geology and Land Survey states that he penetrated it for some distance until he encountered water problems and was forced to turn back. This writer noted the soggy mass of driftwood flooring the tunnel near the mouth and lost all interest in attempting to explore it without suitable equipment and a companion. Leonard North of the Sho-Me Power Corporation states that the idea of utilizing the natural tunnel for a tailrace was abandoned when it was found to have passages branching out from it from which there might be water loss. It was considered more feasible to build the artificial tailrace tunnel which serves today's installation. The outlet to the tunnel on the north side was not visited because of problems of time, brush, and accessibility.

The main virtue of the natural tunnel, in addition to the beautiful drive over it, is the collection of driftwood immediately below the dam and in the mouth of the tunnel. A connoisseur would have fine pickings! Tunnel Dam was reached via the following route:

Miles	
0.0	*Junction of Highways 54 and K, 2 miles west of Camdenton. Go south on K.*
7.8	*Turn right off K onto Tunnel Dam Road.*
8.85	*Bear right at fork.*
10.1	*Bear right at T-junction.*
10.9	*Bear right at fork.*
11.75	*Parking area for overlooking the narrows at left. This spot overlooks the dam and reservoir on the south side of the ridge.*
11.85	*Park in saddle of ridge on either side of the road. From the parking area on the left side of the road (south side) a path leads down a ravine to near the river and thence upstream to the dam and tunnel mouth. No path was found from the parking area to the downstream side of the natural tunnel.*

308. THE SINKS NATURAL TUNNEL

Shannon County, 19 miles north of Eminence and east of Highway 19, on Sinking Creek, in SE¼ NW¼ NW¼ NW¼ sec. 27, T. 31 N., R. 4 W., The Sinks 7½-minute Quadrangle.

The Sinks is the only navigable natural tunnel in Missouri (fig. 138). It is about 200 feet long, approximately 30 feet wide, and varies from 12 feet in height down to a ceiling which requires a canoeist or johnboat passenger to do a deep bend to avoid hitting his head on the ceiling during a very short portion of the enjoyable float. The surface of the water is near the top of the tunnel and soundings show a depth of approximately 30 feet from below normal water surface to the bottom. The tunnel also has appropriately been called the Emerald Grotto because of the distinctive water color reminiscent of its spectral cousin, the Blue Grotto of Capri.

The tunnel is a classic example of a stream which formerly took a course (in this case to the right) around a narrow neck in a meander loop but found a crevice which it enlarged to cavern dimensions, taking advantage of this shortcut to shorten its course by more than 0.5 mile.

The spelling of Sinking Creek has been debated and some maps designate it as "Sinkin," leading to two hypotheses: one would hold that Sinking is the true name and that "Sinkin" is a gerund corrupted by dropping the "g." An alternate hypothesis would hold that "Sinkin" refers to the characteristic of the stream to disappear or sink into its bed. The sink-in characteristic is demonstrated in times of high water when

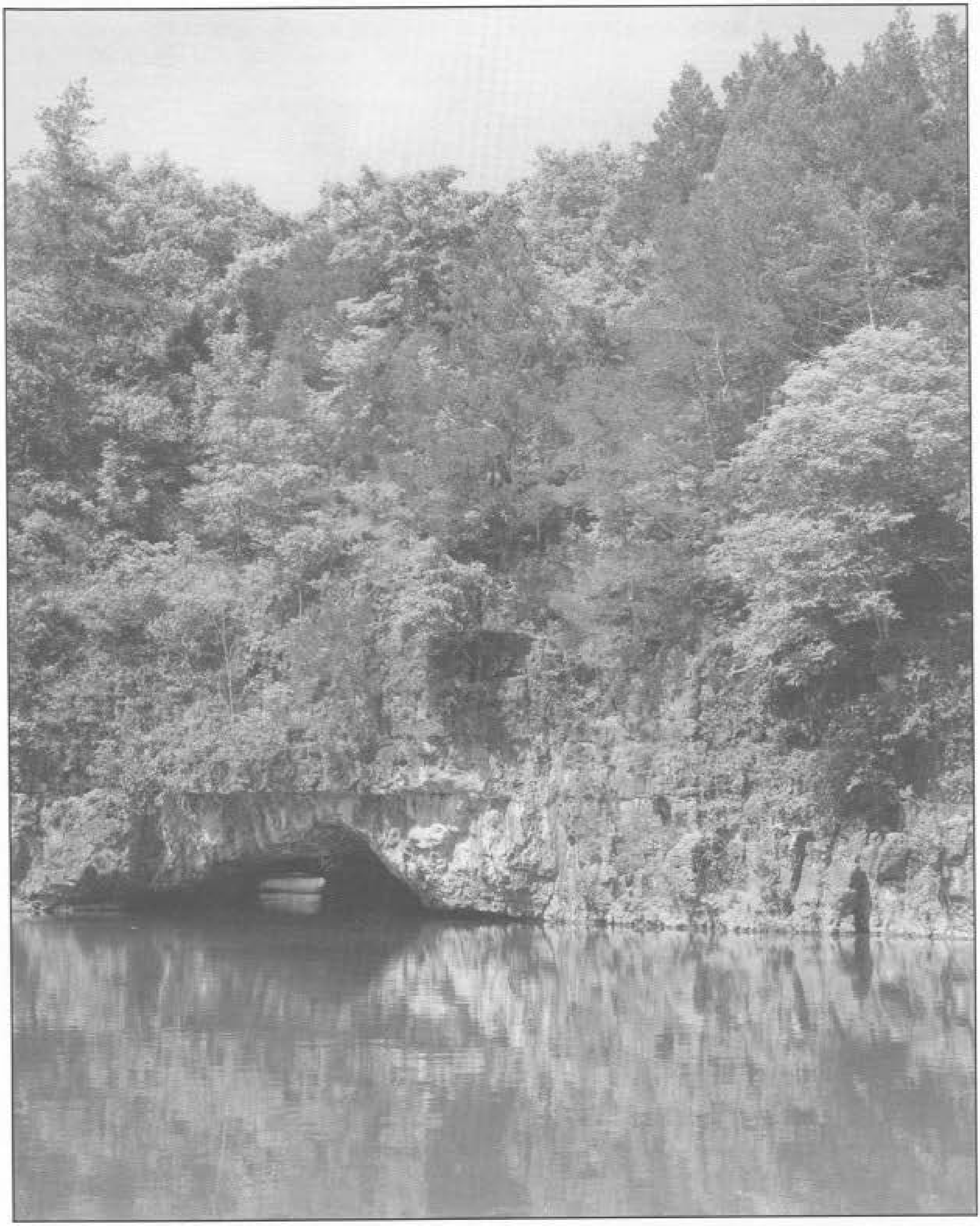


Figure 138

The Sinks Natural Tunnel in Shannon County. Photo by Jerry D. Vineyard.

the stream backs up at the entrance of the tunnel and a vortex is formed as it swirls into this giant storm drain.

The Sinks area is a classic area of karst features, including several springs and Lost Silver Cave with its legends of buried treasures. The abandoned meander loop has been dammed and utilized as a lake which, in turn, is used by beaver and fish.

The sinks are commonly visited via the following route:

Miles

0.0 *Turn east off Highway 19 onto A, 19 miles north of Eminence or 27 miles south of Salem.*

0.45 *Bear right on Highway CC.*

2.35 *End of Highway CC, bear left onto gravel road (low-water bridges may be flooded after heavy rains).*

3.6 *The Sinks.*

309. JURGGENMEYER NATURAL TUNNEL (ARCH CAVE)

Miller County, 2 miles east of St. Elizabeth, in east bluff of Tavern Creek, SW¼ SW¼ NW¼ sec. 35, T. 41 N., R. 12 W., Meta 7½-minute Quadrangle.

The topographic map shows a cave at this locality, and it also shows a swallow hole or sinking stream, because it is much more of a tunnel than an arch.

The tunnel is 350 feet long. The upper entrance is about 110 feet wide with a 30-foot ceiling which flares to a lower entrance 150 feet wide with a ceiling at least 50 feet tall. In the modern era, its appearance calls to mind an aircraft hangar. Stored farm implements and an installation for a hay fork bring memories of the recent past while fragments of Indian pottery and mussel shells at the south edge of the upper entrance indicate its popularity in prehistoric days. A reconstructed Indian burial exhibit in the State Capitol Museum in Jefferson City entitled "Ceremonial Burial of a Mother and Child" is from this tunnel, and the variety of human activities represented by prehistoric and historic artifacts and construction shows a long history of popularity.

The entire tunnel is in the Gasconade Dolomite and it is an obvious case of lateral piracy of a drainage system through a ridge separating the system from the valley of Tavern Creek. The topographic map shows that much of the drainage in the western half of sec. 35 at one time entered Tavern Creek via a ravine north of the tunnel. This drainage, which is now short-circuited through the tunnel, undoubtedly contributed to its enlargement.

Of the many natural tunnels visited, this one ranked among the leaders in grandeur and interest and the bit of walking needed to visit it is certainly justified. The serious student of geology should inspect the topographic map using some magnification to see the relationship between the drainage and the tunnel system.

According to Ball and Smith (1903, p. 16) and others, Tavern Creek's name is a corruption of the most appropriate original name, "Cavern Creek."

To reach the tunnel, go southeast on the unmarked road on the southeast edge of St. Elizabeth. This road has been blacktopped near town but becomes gravel a short distance outside the city limits. It angles southeast, crossing Tavern Creek over a steel cable suspension bridge with planks which ripple and sway in advance of and behind a vehicle. After crossing the bridge, continue eastward and then northward for 1.1 miles, enter a private lane on the left and go west to near an old cabin. An electric powerline extending westward may be followed on foot along a faint trail which crosses the natural tunnel. If the weather is dry, one can drive very close to the tunnel. The easier approach is from the upstream side, but the more impressive view is encountered by descending the bluff to the left of the powerline and entering by way of the mouth.

310. WOODWARD HOLLOW NATURAL TUNNEL

Laclede County, 8 miles west of Lebanon and 1 mile south of Highway 64, in NE¼ SE¼ NE¼ of south square mile sec. 4 (long section), T. 34 N., R. 17 W., Bennett Spring 7½-minute Quadrangle.

This tunnel is less than 2 miles from Bennett Spring Tunnel (No. 316). According to Vineyard (1973a), it requires artificial light and some crawling, is approximately 100 yards long, and penetrates a loop on a tributary entering Woodward Hollow from the south. The tunnel trends north-northwest through a rock neck on the inside of a sharp stream bend which is concave to the west. The tunnel is about 0.1 mile west of the east section line about 0.7 mile north of the south section line.

311. JAM UP NATURAL TUNNEL

Shannon County, on Jacks Fork, 7 miles northeast of Mountain View, near center SE¼ sec. 4, T. 27 N., R. 6 W., Jam Up Cave 7½-minute Quadrangle.

Jam Up Natural Tunnel system is not as grandiose as Grand Gulf (No. 338) but contains more variety and is a compact example of karst phenomena ideal for general science and geology field trips yet sufficiently varied and spectacular to be of interest to the layman. A visit would be most appropriate in the winter when the lack of foliage would permit a better birds-eye view of the relationship between surface and subsurface drainage and when climbing would be more enjoyable. In the interest of safety, planning should include a companion, flashlights, and reasonably dry surface conditions for descent into one of the steep-walled sinkholes. Those experiencing love at first sight might wish to revisit the locality after a heavy downpour to observe the drainage system when it is overtaxed.

As shown on the drawing (fig. 139), Jam Up Creek goes underground in a large sinkhole and follows a natural tunnel northward for nearly a quarter of a mile to Jacks Fork where the exit is represented by Jam Up Cave. A sinkhole entrance to the natural tunnel exposes a segment of this subterranean drainage through a natural skylight.

In the geologic past, Jam Up Creek and the valley occupied by Lost Hollow were portions of a single stream system, but Jam Up Creek went underground into the cavern system, leaving Lost Hollow stranded with very little runoff water. Where Jam Up Creek now goes underground into the Gasconade Dolomite, a cave 25 feet wide with a 10-foot ceiling attempts to handle the drainage. It is not completely successful as shown by the accumulation of driftwood to heights exceeding that of the cave roof. The driftwood accumulation may have inspired the name Jam Up Cave, as well as Jam Up Creek; however, the cave at the tunnel exit contains huge blocks of dolomite which partly obstruct the passage, suggesting either wood or dolomite debris were responsible for the name.

This locality was visited, with no companion, when the ground was wet from heavy rains, and when the temperature was high. Consequently, no attempt was made to make the steep climb down Jacks Fork bluff to Jam Up Cave nor to descend the slippery path into the vertical sinkhole which acts as a skylight to the tunnel.

Bridge (*in* Dake and Bridge, 1923, p. 7-9) described the cave system very well and a quotation from that out-of-print publication is appropriate:

"About four miles above Rymer's Ranch, a magnificent cave opens into a great cliff face in the right bank of the river. The arch is seventy to eighty feet high, and at least 100 feet wide. The entrance is partially blocked by a great pile of huge tumbled blocks of dolomite about thirty feet high, filling all of the entrance except a narrow channel on the east (downstream) side, even this is partially blocked by the same material, Plate IV, A.

"Many of the individual blocks measure 6 x 8 x 10 feet, or thereabouts. From the tip of this mound of rubbish, a good view of the interior cave may be obtained, Plate IV, B.

"The cave bears almost due south and may be traversed for about 400 feet, where

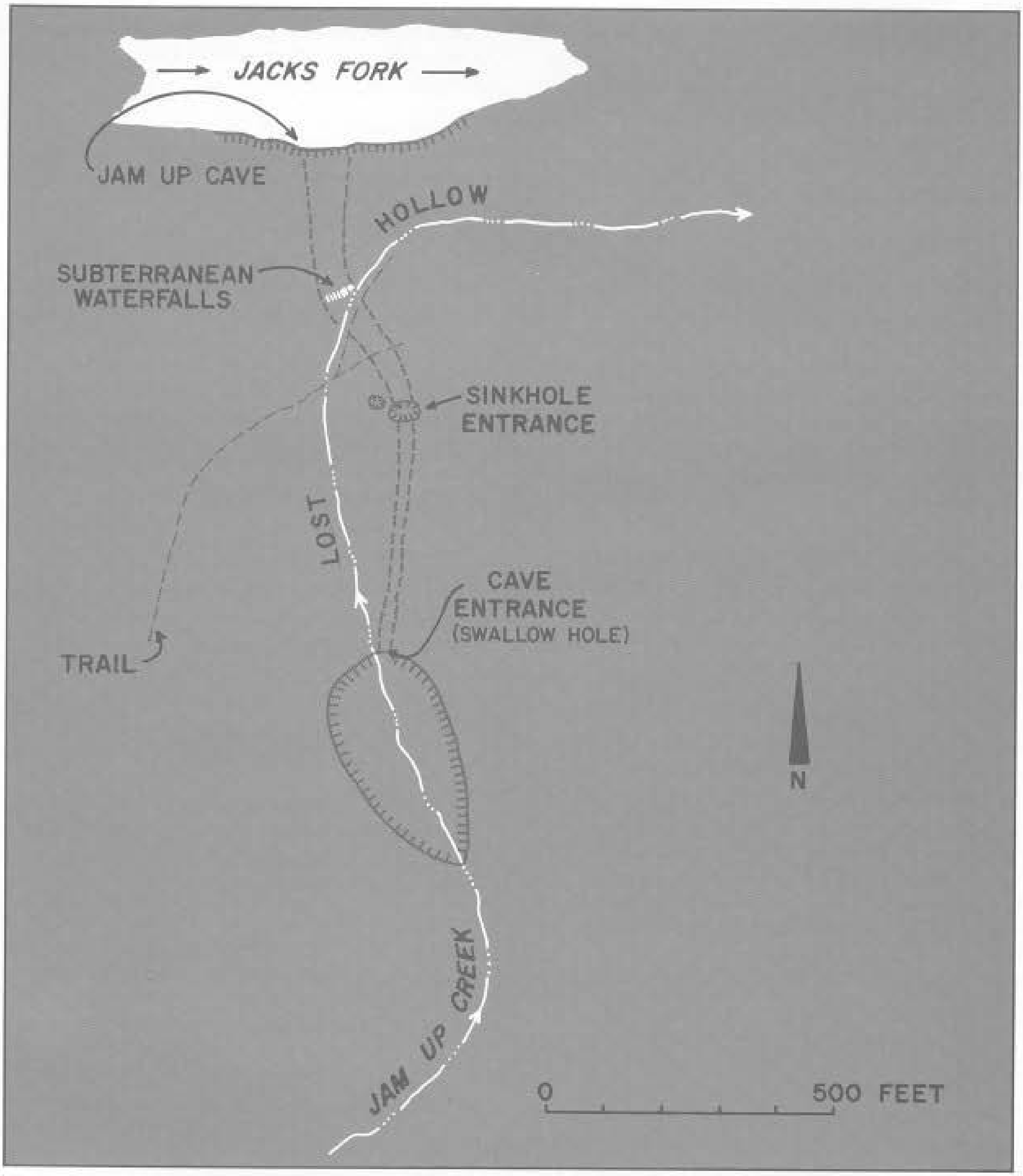

JACKS FORK
JAM UP CAVE
HOLLOW
SUBTERRANEAN WATERFALLS
SINKHOLE ENTRANCE
LOST
CAVE ENTRANCE (SWALLOW HOLE)
TRAIL
N
JAM UP CREEK
0
500 FEET

Figure 139

Sketch map of Jam Up Natural Tunnel System.

further progress is stopped by a twenty-foot cliff and waterfall. The cave at this point is thirty feet high, and perhaps fifty feet wide.

"At the time of the visit very little water was flowing through the cave, but the polished surface of the fallen blocks, and the huge logs stranded on ledges twenty feet or more above the floor served to indicate the volume of water which passes through this outlet in the rainy season. The falls are well lighted from sinkholes farther back in the cave.

"A steep trail climbs to the top of the bluff, crosses a sharp ridge on the Roubidoux sandstone, and immediately descends into a broad valley, which is now occupied by no stream. On the south side of this valley there are two sinks, the mouths of which are about twenty feet above the valley floor. These sinks are elliptical in shape, and show plainly the influence of jointing in their development. The larger sink goes down about fifty feet to a large room; a passage leads off to the south, but this is filled with water from wall to wall and cannot be easily explored. Other passages lead off to the north of the brink of the falls, from which vantage point an excellent view of the lower cavern is obtained (Plate V). The rock surface here is well polished, pot holes are numerous, and evidences of solution along joint planes are very abundant."

The Jam Up system ranks with Grand Gulf and Hahatonka as classic Missouri karst locales. The Devil's Well-Cave Spring system is also comparable but unfortunately (or perhaps fortunately) not as accessible to the amateur explorer, despite its location in the Ozark National Scenic Riverways.

The system was reached via the following route:

Miles

0.0	*Junction Highways 60 and OO, 3 miles east of Mountain View. Go north, then east on OO.*
2.35	*Terminus of Highway OO at T-junction. Continue straight ahead (east) on rough road. A car with sufficient clearance can utilize this road and trail eastward and northward for more than a mile and a half to the west valley wall of Jam Up Creek. This route leads by the foundation of a house on the right, and about a quarter of a mile beyond it the road forks at a cleared area with large rock piles. At this fork, bear right and continue until the road begins to descend into the valley. The ordinary passenger car would not be able to follow the trail any further; therefore, walk down the trail shown on the accompanying sketch. A topographic map of the area and compass are useful for navigational purposes and to aid in visualizing the drainage changes.*

312. MOSSY SPRING TUNNEL (JDV)

Stone County, in a bluff area along James River arm of Table Rock Lake, 5 miles northeast of Cape Fair, in NE¼ NE¼ NW¼ sec. 32, T. 23 N., R. 24 W., Cape Fair 7½-minute Quadrangle.

The 30-foot long tunnel has a main entrance 12 feet wide and 5 feet high, with three moss-covered cascades. A small spring emerges from the wall halfway through the cave, according to Mr. Scott House.

313. SANDY CREEK NATURAL TUNNEL

Lincoln County, 6 miles southwest of Eolia, in SW¼ NE¼ NE¼ sec. 15, T. 51 N., R. 2 W., on west side of Sandy Creek, Louisville 7½-minute Quadrangle.

Anyone wishing to study this tunnel *in toto* should bring a rope and be prepared for climbing because it contains a steep, slippery incline terminating at a bluff 50 feet above Sandy Creek. Because the tunnel trends southeast and the entry is the easily accessible part, the photographer could take a silhouette shot into the tunnel in mid-morning or a late afternoon sunlight shot of the entry.

The tunnel, which is in the Kimmswick Limestone, is narrow and crevice-like. The entry is 12 feet wide and 16 feet high, but the tunnel becomes more crevice-like toward the mouth where it is estimated to be 8 to 10 feet wide and 30 feet tall. The lower dimensions are estimated because the writer had no climbing rope, was alone, and is allergic to slippery slopes terminating in sheer bluffs. The tunnel may have exceeded 200 feet in length originally. This condition is suggested by the steep walls of the draw immediately upstream from the tunnel, which are interpreted as remnants of a once-larger cavern that was reduced to the present tunnel length when the roof was destroyed by erosion.

Stream piracy created this tunnel when the branch took a subterranean shortcut to Sandy Creek by way of the cave system. This branch formerly turned to the right at the head of the canyon and flowed south across a gentle saddle crossed by the trail to the tunnel.

The site is east of Missouri Highway HH and may be reached by taking HH south from U.S. Highway 61 south of Bowling Green or by taking Missouri Highway K through Whiteside west from Highway 61 south of Eolia. Directions are most easily given from the junction of Highways HH and K, 8 miles west of Highway 61. From the HH and K junction, take HH north for 0.2 mile to a farm home. Park at the home and after obtaining access permission, follow a trail which is a continuation of the lane to the southeast for 300 yards to a shallow draw draining to the south. Turn north (left) at the draw and follow it to the east-draining draw which enters Sandy Creek via the tunnel.

Rattlesnake lovers might wish to visit the Devil's Backbone 2 miles to the northwest. Local tradition holds that rattlers may always be seen by May 2nd or 3rd on this narrow curved divide in the common corners of secs. 4, 5, 8, and 9, T. 51 N., R. 2 W.

314. FOWLER NATURAL TUNNEL

McDonald County, 1.8 miles west of Powell, on northwest-draining tributary, in NE¼ SE¼ NE¼ sec. 18, T. 22 N., R. 30 W., Bethpage 7½-minute Quadrangle.

Those approaching the Elk River country of extreme southwestern Missouri from the northeast might well take an extra hour and travel via Powell on Missouri Highway E, visiting the natural tunnel a few steps off the gravel road leading from Powell to Pineville along the scenic Big Sugar Creek Valley.

At Powell go 1.8 miles west from Highway E on the gravel road paralleling Big Sugar Creek at the base of the south bluff. This mileage takes one to a northwest-flowing tributary which the gravel road crosses. Walk up the tributary for approximately 100 yards to the tunnel.

The lower (northwest) end of the tunnel has a 15-foot ceiling which is approximately 4 feet thick and has a 25-foot span. From this lower end the tunnel leads due south for 150 feet and then turns northeast (N 70° E) for 55 feet to the upper mouth. At the turn, the tunnel continues south into a small cave.

The right-angled tunnel system exemplifies the tendency of such tunnels to follow a geometric, fracture-controlled path. Percolating water dissolved the St. Joe limestone along these fractures to create a cave system. The surface wet-weather stream once flowed along the northeast side of the tunnel over a saddle between it and the ruins of a concrete foundation. The stream took a slight shortcut through the cave system (another case of stream piracy) and is today enlarging it by erosion.

A road formerly crossed the stream over this tunnel and Schell (1969, p. 49-50) gives an explanation for the concrete foundation as well as a testimony to the popularity of the site. He states that in the 1920's, Dr. Isom, who practiced in the area, acquired the land and built two houses for campers. He was building a resort house over the spring east of the tunnel when he was found dead, either because of a fall from the framing or a heart attack.

The tunnel has a long history of usage for picnics as well as Fourth of July and Easter observances. Schell tells of a balloon ascension from the site *circa* 1920. The large audience was further treated to a parachute jump from the balloon. The chutist landed in the top of a large tree and *"...found himself in much difficulty trying to extricate himself from his parachute and the treetop."*

Bee Bluff, a mile east of the tunnel on the north side of Big Sugar Creek, is also described by Schell (p. 33) who says it is so named because of cavities in its face which serve as repositories for honey. Regarding these hives, Schell says *"...They were there when the first settlers came and man has never known it to be vacated. Neither as far as has been known, has man ever been able to climb up to where the bees enter their home in the cliff, let alone rob them of their honey."*

See page 81 (No. 115) for the exact location of Bee Bluff.

315. TUNNEL CAVE

Osage County, 7 miles northwest of Belle, crossed by gravel road, in SW¼ SE¼ NW¼ NW¼ sec. 10, T. 41 N., R. 8 W., on tributary to Buck Elk Creek, Summerfield 7½-minute Quadrangle.

This natural tunnel is easily accessible and also plays the lead in a stream piracy drama with the complete scene and all of the characters visible on one stage and from one point.

The tunnel is in cherty Gasconade Dolomite, has a span of 30 feet, a clearance of 5 feet, and an underground passage length of 110 feet. It now carries the drainage for nearly a square mile and doubles as a livestock pass under the road.

The history of stream piracy is obvious and may be seen nearly in its entirety from the road atop the natural tunnel. In the geologic past the west-flowing stream A-B east of the tunnel joined Buck Elk Creek at point C. However, a tributary of Buck Elk worked headward from D, found a joint or fissure in the ridge separating Buck Elk from stream A-B-C and enlarged this opening to the point where flow was diverted at point B.

As shown in figure 140, B-D is the captor or pirate, A-B is the captured stream, and the broad but nearly abandoned valley northwest of C is the beheaded stream. This broad abandoned valley and the divide in it marking the head of the reversed stream are conspicuous. The barbed tributary is a classic example of a stream making an acute turn to empty into a stream which at one time flowed in the opposite direction.

The following route was taken north from Belle on Missouri Highway 89:

Miles

0.0	*At railroad tracks in Belle.*
3.7	*Turn left off Highway 89 at Pilot Knob sign after topping crest of hill.*
5.4	*Bear left at junction.*
6.7	*Bear right at T-junction.*
7.3	*On gravel road over natural tunnel, looking into front of farmhouse. The span and width of this tunnel are such that undoubtedly many have driven over it assuming it is man-made. This illusion is further strengthened by the arched nature of its upper surface which produced the hump common on many of the small old country bridges.*

Directions for reaching the tunnel from the north off Highway 89 are simpler. Check mileage at the Gasconade River Bridge east of Rich Fountain and bear right off the highway 2.7 miles from the center of the bridge. This junction also has a Pilot Knob sign. Follow the gravel road for 5.5 miles to the natural tunnel.

316. BENNETT SPRING NATURAL TUNNEL

Laclede County, 9 miles west of Lebanon and 3 miles upstream from Bennett Spring State Park, on tributary of Bennett Spring Creek, in NW¼ NE¼ NE¼ sec. 8, T. 34 N., R. 17 W., named on Bennett Springs 7½-minute Quadrangle.

Bennett Spring Tunnel is one of my favorites, in part because it persisted in eluding location, but primarily because of its setting — a dramatic and sudden interruption of a normal surface stream — and its textbook exemplification of a variety of geologic phenomena. Campbell (1874, p. 296) referred to a natural tunnel in sec. 21, T. 34 N., R. 17 W., 2 miles to the south; none could be found at that locality and he may have been referring to the tunnel described herein.

This natural tunnel is a surprise! The stream which is flowing west suddenly encounters a

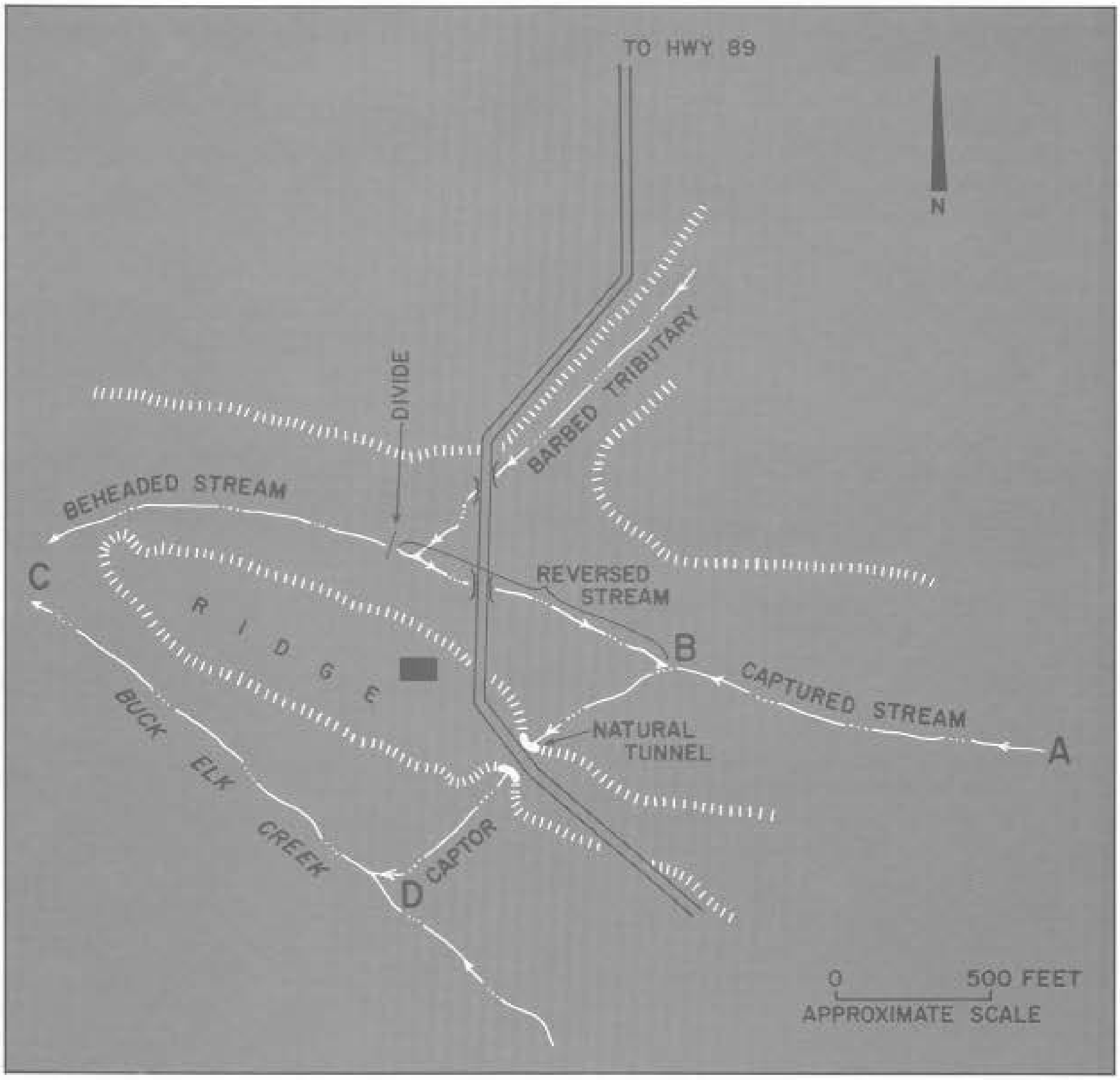

TO HWY 89
N
DIVIDE
BARBED TRIBUTARY
BEHEADED STREAM
C
REVERSED STREAM
R I D G E
B
CAPTURED STREAM
A
NATURAL TUNNEL
BUCK ELK CREEK
CAPTOR
D
0 500 FEET
APPROXIMATE SCALE

Figure 140

Tunnel Cave Natural Tunnel and stream piracy.

sheer bluff with no DETOUR sign and cuts acutely to the right into the tunnel. The entrance to the tunnel is 16 feet high by nearly 50 feet wide and contains the ruins of a futile attempt to block it with reinforced concrete (fig. 141). This attempt to create a lake (*circa* 1964) failed when water impounded after a heavy rain broke through the entrance seal.

Jointing in Gasconade Dolomite obviously controls both the path of this 100-yard long tunnel and the orientation of the bluffs at the entrance as shown by the pronounced geometric grain.

Subterranean stream piracy is responsible for the Stygian stint of this stream. In the past it turned to the left upon encountering what is now the vertical bluff and made a clockwise loop around the spur it now penetrates. The abandoned channel of this loop is nearly half a mile long and is shown on the Bennett Spring

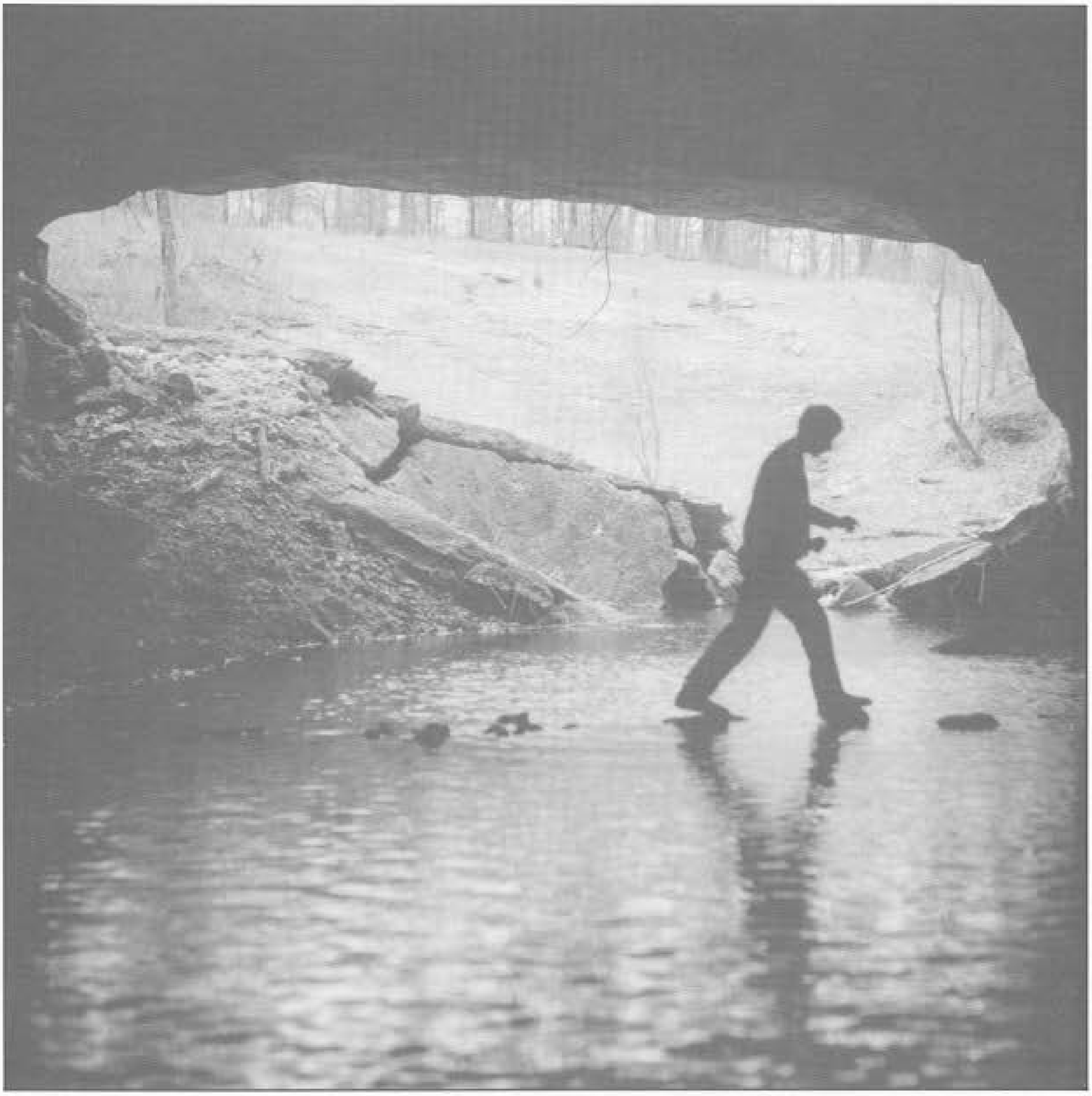


Figure 141

Bennett Spring Tunnel in Laclede County. Photo by Jerry D. Vineyard.

topographic map. The stream shortened its course by entering a subjacent cave which is preserved in part as the tunnel. Blocks of dolomite, as large as 5 x 8 x 13 feet, clustered at points extending nearly 100 yards downstream from the tunnel, are probably ruins of the once larger cave now represented by the tunnel (fig. 142).

The property on which the tunnel is located is now part of Bennett Spring State Park.

Joints were enlarged by solution to create the cave system, and the parallel orientation of this system and bluffs is strongly suggestive of joint control in bluff alignment. Some of the bluffs, the north-south bluff at the upper end of the

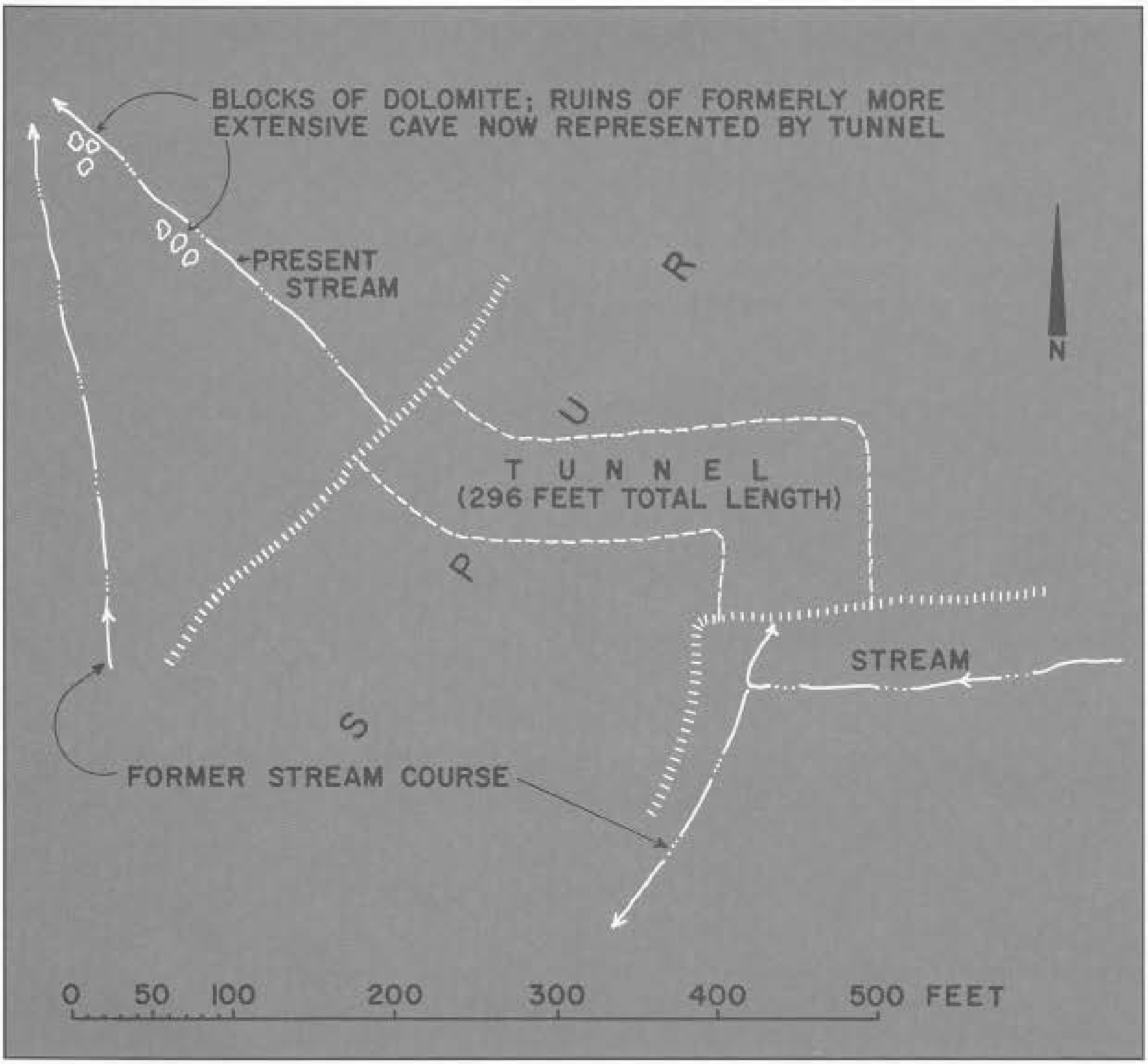

BLOCKS OF DOLOMITE; RUINS OF FORMERLY MORE EXTENSIVE CAVE NOW REPRESENTED BY TUNNEL
PRESENT STREAM
R
U
P
S
TUNNEL
(296 FEET TOTAL LENGTH)
STREAM
FORMER STREAM COURSE
N
0 50 100 200 300 400 500 FEET

Figure 142

Subterranean piracy and Bennett Spring Natural Tunnel.

tunnel for example, may be eroded remnants of former cave walls.

The tunnel may be reached via Highway 64 west of Lebanon and west of Bennett Spring State Park. Directions for reaching it from either direction are as follows:

Eastbound on Highway 64:

Miles

0.0 At junction with Highway 64A (Bennett Spring Spur).

2.75 Turn right (south) off Highway 64 onto gravel road.

Westbound on Highway 64:

Miles

0.0 At junction with Highway KK, 5 miles west of Lebanon.

3.5 Turn left (south) off Highway 64 onto gravel road.

Follow gravel road south for 2.35 miles, then turn right (west) at T-junction. From T-

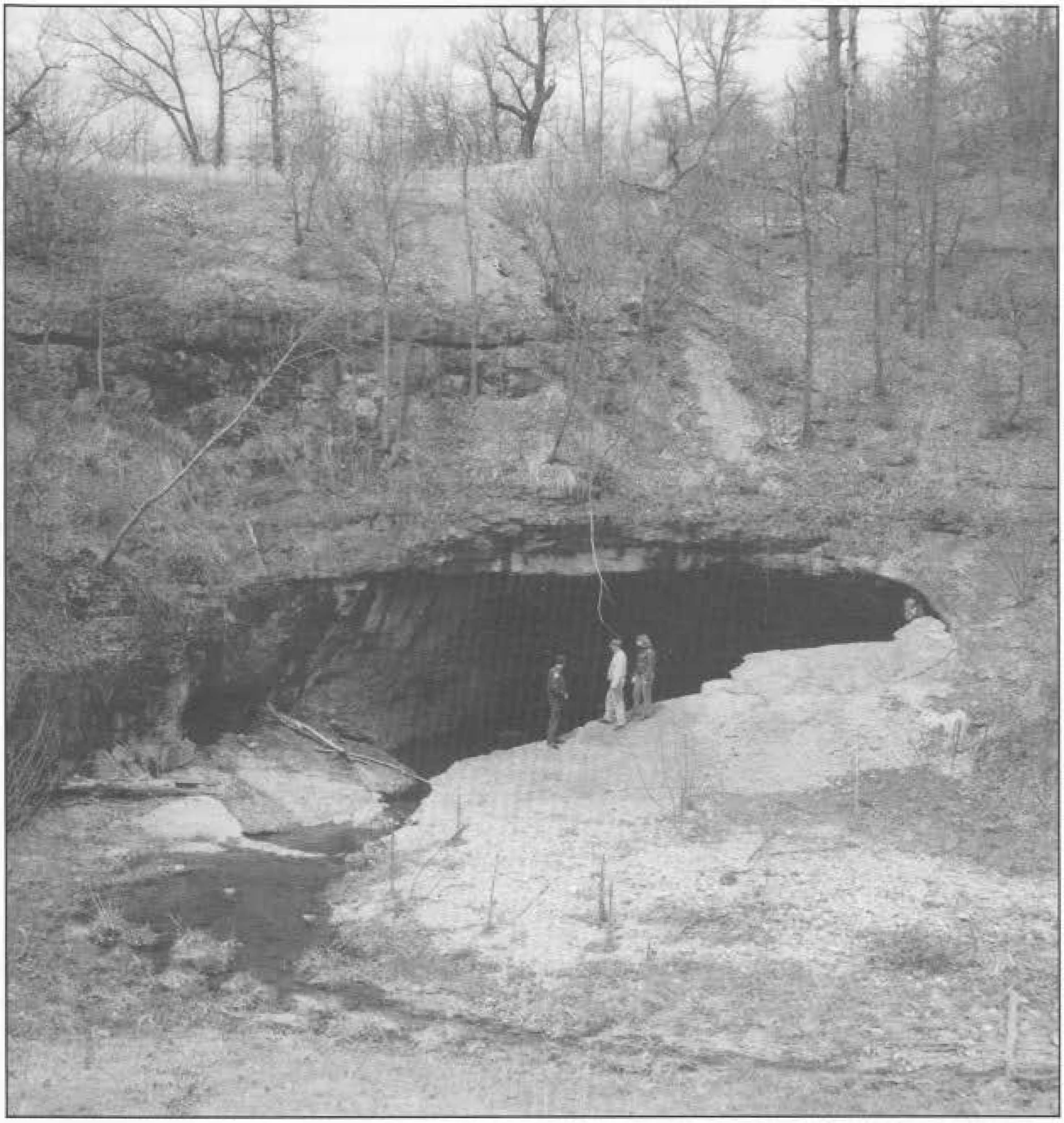


Figure 143

Bennett Spring Natural Tunnel. Figures are standing on the remains of an unsuccessful dam. Photo by Jerry D. Vineyard.

junction, drive west 1.75 miles to where the road turns left. Follow the private lane or trail which goes northwest from this corner. A padlocked gate required walking from the corner to the natural tunnel, following the trail which could be driven in dry weather. At a point 1,530 yards from the gate, the trail crosses a low saddle and then continues uphill over the tunnel which is visible ahead to the right in the northwest bluff of the stream (fig. 143).

317. ASH GROVE NATURAL TUNNEL

Greene County, near east edge of Ash Grove, near center E½ SE¼ sec. 20, T. 30 N., R. 24 W., Ash Grove 7½-minute Quadrangle.

Arrival in the town of Ash Grove included a stop for a cup of coffee and inquiries of several local residents regarding the most convenient access to Ash Grove Natural Tunnel. Professional missionary zeal was somewhat shaken upon finding that none of the interviewees had visited this widely heralded natural feature and they were thus immediately stamped as highly provincial. Upon arriving at the natural tunnel (after choosing one of the worst routes) it was found that the analysis of Ash Grove residents was utterly wrong, and it was hoped that no one saw the visitation being consummated. The Ash Grove sewage plant is immediately south of the branch draining into the tunnel and all of its effluent (in 1973) went into the tunnel. As a result, the cursory exploration of the tunnel was a shallow one involving careful selection of stepping stones among the effluent and visions of Jean Valjean in the sewers of Paris. New plant facilities are being planned to eliminate the esthetic problem. A complete exploration of the tunnel was not made and a most sincere "thank you" goes to Bretz (1956, p. 314-315) for a description of the inner and lower parts. A complete issue of the *Ozark Caver* (Thomson et al., 1970) is devoted to Ash Grove Cave, including maps and a much more extensive description than Bretz's.

The mouth, which is approximately 10 feet high and 50 feet wide, forms a symmetrical arch. Upstream from the mouth, a mass of tumbled Burlington Limestone blocks attests to the fact that the tunnel is the remnant of a partly collapsed cave system. Bretz described the cave as having *"...adequate head room and a generous width of 20 to 30 feet..."* but states that there are a number of side passages, the majority of which are dead ends. He describes three entries into this 1,000-foot long tunnel: the portal, a skylight hole about 200 to 300 feet from the exit where collapse of the roof has produced a minor sinkhole, and the exit in the bluff of Sac River.

I chose to enter the cave via a road which corners at the north end of the quarry under which the tunnel passes and was shocked on arriving at the portal to find that a maintained road leads directly to the sewage plant near the portal. Those wishing to visit the cave should check for the easiest method of reaching the plant road. The cave has seen much better days for, according to Perkins and Horne (1883, p. 662):

> *"One large room on the left-hand of the entrance is called the 'ball room' from its being so frequently used as such. The young people of the neighborhood, who are so light as to heart and heels and who often assemble here and dance all care and sorrow away, enjoy not only the exhilarating past time, but the weird surroundings and the plutonian scenery about them."*

They also state (p. 623) that the cave was also sometimes called the Cave of Adullam, named after the cave used by King David as a refuge from Saul and his armies. Mason Cave was another common name for this tunnel in the past.

Regardless of the variable esthetic qualities of the tunnel, those taking Highway 160 northwest from the Springfield area are rewarded with a view of an excellent octagonal brick barn which housed Union soldiers during the Civil War. This barn is on the north side of Highway 160, 4 miles east of Ash Grove or 0.8 mile west of the junction of Highway UU with 160. Slightly over a mile north of Ash Grove is the home of Colonel Nathan Boone, the youngest son of Daniel Boone, which he built in 1837 when he moved his family to Greene County.

318. ROUND SPRING NATURAL TUNNEL

Shannon County, 13 miles north of Eminence, on Missouri Highway 19, at Round Spring, Ozark National Scenic Riverways, NE¼ SW¼ NW¼ sec. 20, T. 30 N., R. 4 W., Round Spring 7½-minute Quadrangle.

Water at Round Spring surfaces in a circular sink structure and then follows a natural tunnel for about 50 feet to the south where it emerges at the base of a low bluff to flow into the Current River. Old timers report boating through the tunnel during low water stages. The tunnel was once a cave from which the spring gushed. The roof of the cave collapsed (or was dissolved) in part, to leave the circular sink exposed.

One geologist of the Romantic Era was so enthralled by the spring that he described the sink as follows (Gallaher, 1900, p. 103):

"Two miles further up the road towards Salem and facing towards the rising Sun is a round abyss in the Earth, about one hundred feet wide and nearly as deep. It stands always about half full of beautiful blue water on whose smooth surface never a ripple is seen. I should have said divine blue, for I cannot disassociate such exquisite blue and white from divinity. That, of course, is the Round Spring. But its name does not begin to convey the slightest conception of its beauty. Lifting your visual orbs from its snow white bottom, fifty feet below, and fixing them on the deep serene, forever mirrored in its placid surface, you have a cyclorama whose ever varying charms will never be eclipsed by anything more beautiful, until you have beheld the objective beautitude of Heaven."

319. GILLIAM NATURAL TUNNEL

Ste. Genevieve County, 5 miles southeast of Ste. Genevieve, in NE¼ NW¼ NW¼ NE¼ sec. 14, T. 37 N., R. 9 E., Ste. Genevieve 7½-minute Quadrangle.

The temperature was 95° when this site was visited and disturbing the cattle who were enjoying the coolness of Gilliam Natural Tunnel produced only minor guilt feelings. This tunnel is associated with the namesake cave from which a spring (shown on the topographic map) flows. The tunnel perforates a divide separating the ravine into which the spring flows from a parallel ravine whose flow also empties into River aux Vases to the southeast.

The cave and natural tunnel do not appear to be part of the same linear system. The cave is in the north wall of a canyon along the northwest side of a ravine and trends northwest. The tunnel trends N 70° E and has a floor which at its upper (south) end is 35 feet higher than the cave mouth. It is 55 feet long, spans about 50 feet at the base, and its ceiling varies from 6 feet high at the upper end to 12 feet high at the lower end. Its roof is from 5 to 12 feet thick on the upper and lower ends, respectively.

Gilliam Tunnel appears to be genetically related to the canyon in which it empties because it curves gradually to the east and then southeast, suggesting that the northwest limestone bluff of the valley into which it empties is the wall of the cave system represented in part by the tunnel. Gilliam Cave which debouches from this 50-foot bluff would be a side passage in the cave system. Gilliam Cave has an entrance 3 feet high and 25 to 30 feet wide which constricts rapidly to about 12 feet. The flow from the spring was somewhat muddy, indicating a close relationship between the numerous sinkholes to the northwest and the effects of heavy rains a few days earlier.

The tunnel was reached from Ste. Genevieve by the following route:

From the roadside park a mile south of Ste. Genevieve, following Highway 61 southeast for 2.75 miles, turning right off the highway onto a gravel road immediately after crossing Dodge Creek. Follow the gravel road for 1.05 miles to a lane leading south off the road to the Francis X. Viox house. This lane is easily recognized as the only one on the south side in the general area and by the sinkholes flanking both sides. After obtaining entry permission at the house, angle southeast for approximately 0.5 mile to an old barn. South of the barn follow a draw, watching the left side for the tunnel which is well above the valley floor of the draw. This route passes through the tunnel to the northwest to enter the ravine from which Gilliam Spring flows. The tunnel is most impressive from the northeast end and a photographer might prefer a mid-morning shot when maximum lighting would be available.

320. SKYLIGHT NATURAL TUNNEL (JDV)

Camden County, 6 miles west-southwest of Macks Creek, in SE¼ NW¼ NW¼ NE¼ sec. 19, T. 37 N., R. 19 W., Branch 7½-minute Quadrangle.

This natural tunnel, in a more appropriate location, could easily have become a forerunner of modern highway interchanges. It is wide (long) enough to have handled two lanes of traffic with a divider, and with a little deepening, could have accumulated two lanes of traffic beneath. It is a delightfully cool place on a warm day, as well as a good lesson in subterranean stream piracy.

The upper end of the tunnel is a sinkhole-swallow hole that accepts part of the drainage from a west-trending opening on the Little Niangua. The entrance is about 10 feet wide and just high enough to stand. Inside, the tunnel becomes wider and higher.

The spacious tunnel is interrupted about 25 feet from the upper entrance by a round opening in the ceiling, roughly 15 feet in diameter. This natural skylight is a place where the ceiling (which is none too thick) collapsed into the tunnel. The debris from this rockfall has long since been moved through the tunnel by floods, and the floor is relatively even; it is easy walking for most visitors.

The tunnel is 120 feet long, widening at its lower end to about 30 feet, with a ceiling height of 15 feet. The bedrock roof of the tunnel is quite thin; probably nowhere more than 5 to 7 feet thick. Thus, in the context of geologic time, this interesting tunnel will be a short-lived phenomenon, but in the context of human time, it will be open for enjoyment for many years to come.

Evidence of destructive processes is obvious in the skylight, but another, less-obvious indicator is a small side niche on the north side of the tunnel, near the lower end. Here a fan-shaped mound of reddish clay and broken rock shows that soil material is moving downward from the surface. On the ground over the tunnel, a small sinkhole corresponds to the side niche in the tunnel. With time, the sinkhole will grow at the expense of the remaining part of the tunnel.

Skylight Natural Tunnel is privately owned; access permission should be sought. A development road runs nearby, parallel to the tunnel, and the upper entrance is easily visible from the road.

Mr. Don Kurz of the Missouri Department of Conservation provided location information about the tunnel.

321. SPEARS NATURAL TUNNEL

Morgan County, 4 miles southeast of Stover, 6 miles southwest of Versailles, on Gravois Creek, slightly south of center west line sec. 20, T. 42 N., R. 18 W. Shown as Spears Cave on Stover 7½-minute Quadrangle.

The larger, downstream portal to this tunnel is some 50 feet high by 40 feet wide with such symmetry and perfectly curved ceiling that its cathedral-like impression almost produced a genuflection despite a Presbyterian heritage. The general upstream trend of the tunnel is S 50° to 60° W with a dogleg in the central part to a more southerly direction. Because of the huge blocks of Gasconade Dolomite on the floor and the dogleg, a flashlight is useful on cloudy days. Daylight barely manages to penetrate its 360-foot length and artificial light is more than a luxury during times puddles need to be dodged.

The tunnel gradually narrows to an upper opening 9 feet high by 15 feet wide, a narrowing which produces a strong Venturi effect. At the time of visiting, the wind was blowing gently from the northeast or into the larger opening. At the smaller downwind opening, the constriction of the tunnel produced a natural wind tunnel, the wind at the large end being a breeze and at the southwest end, a blast.

This tunnel is obviously a remnant of a larger cave system. A 100-foot long canyon at the downstream end of the tunnel represents the ruins of a deroofed portion as does a shorter, shallower canyon at the upstream end. Huge tumbled blocks of Gasconade Dolomite may be ruin remnants of the roof.

The tunnel was reached via the following route from Stover:

Miles

0.0 *Junction Highways 135 and 52 at Stover; go south on 135.*

2.7 *Turn east (left) off Highway 135 onto gravel road.*

4.3 *Continue straight ahead (east and then southeast) at T-junction.*

5.3 *Road turns left; locked gate entrance to private road going straight ahead (south). Take this private road (providing permission for access and unlocking has been obtained).*

5.4 *Park and walk south past corral to stream. Foundation of old house on the left. Tunnel entrance is a short hundred yards downstream from last low dam. Large dolomite boulders on opposite bank of creek mark ravine coming into southwest bank of stream. Follow this ravine up canyon to natural tunnel.*

The tunnel is very impressive but because of the topography, it is difficult to photograph at the larger end without a wide-angle lens.

The topographic map shows the gravel road leading to the private road, continuing southeasterly and following Devils Backbone, a feature that is impressive on the topographic map and probably from a plane, but not narrow enough at the crest to create an unusually scenic drive.

322. ANVIL ROCK NATURAL TUNNEL

Osage County, 3 miles south of Westphalia, in north bluff of Maries River, 150 yards downstream from Highway T, in SE¼ NE¼ SW¼ SE¼ sec. 11, T. 42 N., R. 10 W., Westphalia East 7½-minute Quadrangle.

This natural tunnel has had no known name and is christened Anvil Rock because of the protruding pointed ledge of rock which forms an anvil's horn at the terminus of the rock wedge that the tunnel penetrates. Because the tunnel penetrates a mass of rock which is anvil- or pie-shaped as viewed from above, the passage is 30 feet long on the bluff side, and only 11 feet long on the valley side. It is 16 feet wide with a 7-foot high ceiling which is 6 feet thick (see fig. 144).

Obviously, fractures determine the existence of this feature. It follows a joint system trending N 40° E which was enlarged by solution of Roubidoux dolomite. The anvil horn is also produced by a fracture enlarged to a fissure which has isolated a sliver of rock at the tip of the wedge-shaped mass.

The site is easily reached by taking Highway T south from the junction with Highway 63, 2 miles southeast of Westphalia. From the junction, follow Highway T for 1.4 miles to where a private drive bears to the right, south of the first rockcut. This drive crosses the predecessor to Highway T a few yards west of the present highway, and the old road may be followed parallel to the highway almost to Maries River. The tunnel is easily visible from this old road in the right-hand or west cut and is most easily reached by following a path along the lower part of the bluff and entering the tunnel on the southwest side. The tunnel is also visible from the Highway T bridge, even in the summer, and a drive across the bridge, which is 0.2 mile beyond the private drive turnoff, is worthwhile to get a preview of it and the rock anvil horn. Photography is not feasible in the summer but might be considered on a winter afternoon looking upstream to the northeast to catch the Anvil Rock and tunnel with natural lighting.

Osage County is well endowed with natural tunnels, having at least four, plus two artificial railroad tunnels, one passing underneath the town of Freeburg and the other one, also on the Rock Island line, 3 miles northwest of Argyle.

323. DEVILS KITCHEN (DEVILS FIREPLACE)

Camden County, in ridge near east edge of sinkhole, in NE¼ NE¼ SW¼ SE¼ sec. 2, T. 37 N., R. 17 W., on south side of Highway D, 0.25 mile south of Hahatonka Natural Bridge (also see Nos. 339 and 222), Lake Niangua 7½-minute Quadrangle.

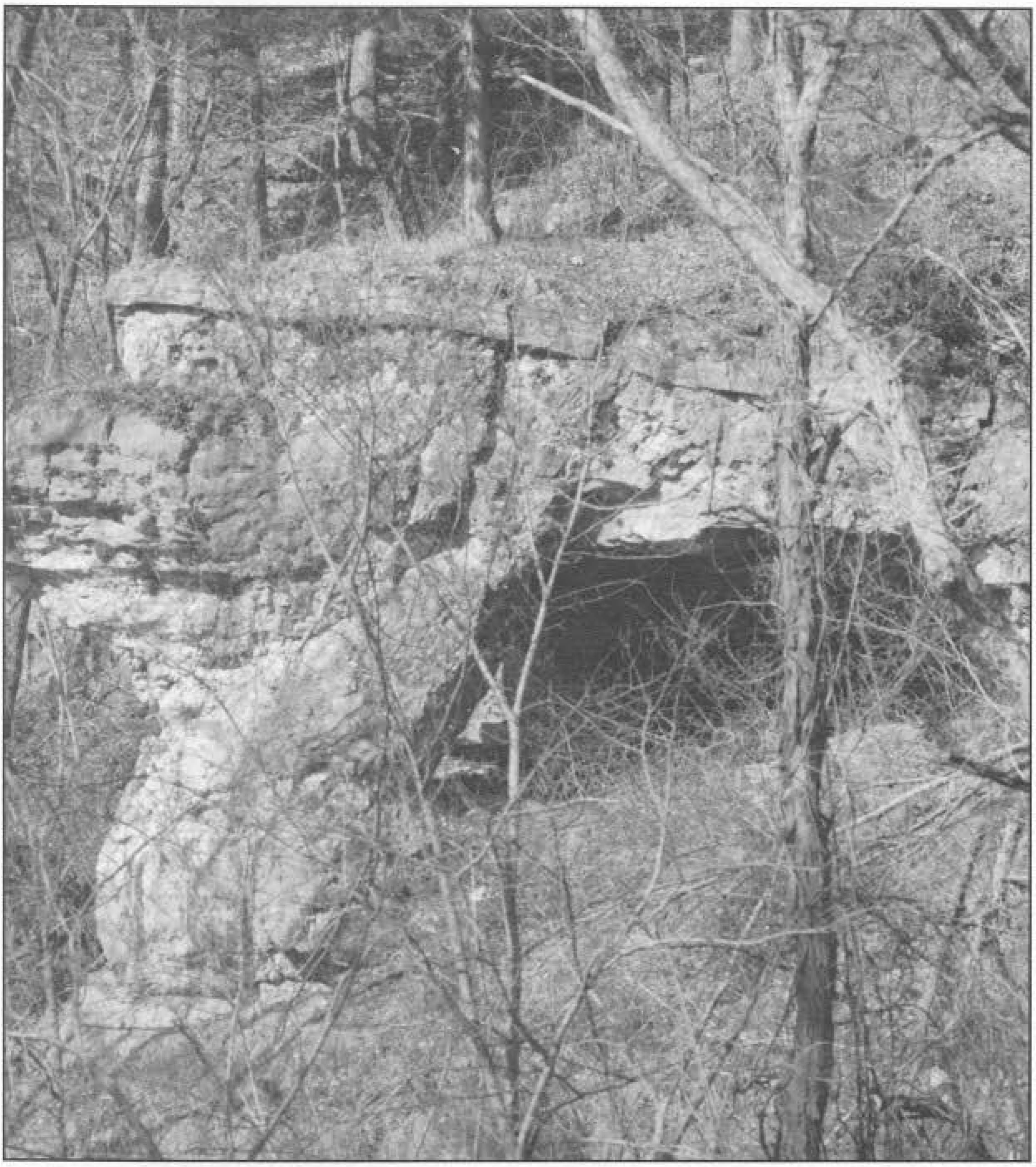


Figure 144

Anvil Rock Natural Tunnel near Westphalia. Photo by Jerry D. Vineyard.

The Devils Kitchen has also been designated as the Devil's Fireplace. It is a very shallow cave with a long slot at the rear which connects with the surface. It might also be considered a natural bridge or arch and such a designation will certainly be appropriate in a few thousand years when the slot enlarges to produce more of an arch than cave effect.

The feature is on the north side of a west-trending spur projecting into a large sinkhole from the eastern margin. This projecting spur forms the Devils Promenade that extends from the rim of the sink down the spur to his kitchen. The cave opening is on the north side of the spur near its terminus and has an opening 30 feet wide, a maximum ceiling height of 20 feet, and a depth of 25 to 30 feet. The roof of the cave is exceptionally unsound and huge slabs which partly filled the opening suggest caution in exploring the site.

The roof of the cave is 12 feet thick and is penetrated at the back of the cave by a vertical fissure skylight or chimney approximately 15 feet long and 4 feet wide, trending N 70° W. The easiest entry to the cave is through the arch opening on the flank of the spur, but the hardy can descend into the cave from the top of the spur as Santa Claus would. The whole system is developed in the Eminence Dolomite and the presence of the spur extending as a rock peninsula into the sinkhole suggests that it was a slice of rock isolated by fractures having a trend approximately parallel to that of the fissure.

The site is most easily reached using the topographic map and walking from Highway D along the northeast margin of the sinkhole to where the rim extends as a spur, following the spur to the fissure marking the top of the chimney. The slot for the chimney does not admit much light and a photograph of the cave is not particularly rewarding because the result is similar to that of any fairly shallow cave.

324. PENINSULA CAVE NATURAL TUNNEL

Pulaski County, Fort Leonard Wood Military Reservation, near east edge of county, in south-facing bluff of Big Piney River, in NE¼ NW¼ SE¼ sec. 9, T. 35 N., R. 10 W., Devils Elbow 7½-minute Quadrangle.

Peninsula Cave Natural Tunnel is so named because it is on a narrow ridge paralleled by an elongated sink structure on the north side and sheer bluffs of the Big Piney River on the south side. A gravel road follows this narrow ridge eastward from Fort Leonard Wood's permanent buildings to terminate at the tip of the peninsula in bottomlands of the Big Piney. The tunnel is most easily found by using the topographic map and entering the elongated sinkhole on the north side of the gravel road where the entrance is in the southeast corner of the most westerly sink structure shown.

The tunnel can be walked (and duck-walked) south to the bluff of the Piney. A light is needed and crossing one large fissure may not be easy for the short legged but, in general, the traverse is an easy one which could safely be made alone. The tunnel is estimated to be a hundred yards long and at no point is the ceiling low enough to make the journey difficult. In the upper and lower parts, headroom is ample for standing.

The elongated sinkhole shown on the map is probably a collapsed cave system nearly half a mile long. This natural tunnel is a major drain for the westernmost sinkhole and another natural tunnel, too small to be crawled, acts as a drain for the easternmost depression. The upper entrance of this eastern tunnel is where the sinkhole wall comes closest to the gravel road and a steep trail leads down to the entrance.

Detailed directions for reaching the area are not given because the topographic map is a necessity and mileage directions would not be accurate enough for precise navigation. The visitor will not have the opportunity for productive photography here, but in addition to the tunnel traverse could also go to the east end of the gravel road and appreciate Spring Creek Bluff from the east side of the Piney. This 350-foot bluff contains a conspicuous Indian shelter, Pillman Cave. Both this bluff and the natural tunnel bluff are composed of the Gasconade Dolomite.

325. TUNNEL CAVE

Pulaski County, under Highway 17, 3 miles south of Crocker and 6 miles north of Waynesville, in SW¼ SE¼ sec. 33, T. 37 N., R. 12 W., Crocker and Hancock 7½-minute Quadrangles.

Bretz (1956, p. 424-426) cites this as a classic example of subterranean stream piracy. Water enters this tunnel from a sinkhole in a ravine more than 2 miles long on the east side of Highway 17 and penetrates the ridge, passing under the highway through this 1,000-foot natural tunnel drain into the Gasconade.

326. LITTLE ROCKY CREEK TUNNEL

Shannon County, 8 miles southeast of Eminence and 3 miles northwest of Rocky Falls Shut-In, on north side of Little Rocky Creek, in W½ sec. 1, T. 28 N., R. 3 W., Stegall Mountain 7½-minute Quadrangle.

Bridge (1930, p. 45) describes this as follows:

"...a large sink, from the bottom of which a tunnel slopes off to the east and south and finally emerges in the head of a small ravine. The tunnel is about 10 by 12 feet at the upper entrance, and somewhat larger at the lower end."

A sink is shown on the modern topographic map, but no exit is indicated. Bridge's description and the topography suggest that the tunnel is between 0.125 and 0.25 mile long. Probably lights and some crawling and climbing are involved?

327. BLUE SPRING TUNNEL (JDV)

Shannon County, near Blue Spring on the Jacks Fork, 2.5 river miles downstream from Highway 17 crossing, in NE¼ NE¼ sec. 31, T. 28 N., R. 6 W., Pine Crest 7½-minute Quadrangle.

Blue Spring Tunnel is one of an exceptional collection of karst features in the Blue Spring area. The tunnel is in the northeast corner of a large rock mass that is separated (upstream) from the main Blue Spring bluff. It is a tunnel to nowhere. One entrance is on top of the bluff; the other comes out about 15 feet up on a sheer rock wall. The tunnel is about 30 feet long, about 5 feet wide, and only high enough for a short person to walk through.

The student of karst will be fascinated by the numerous caves and solution openings in the area, and by Blue Spring itself, which is a large cave-in-the-making.

The area is exceptionally scenic. It is best reached by canoe from the Highway 17 bridge; if one chooses the only overland route, from the south, one must cross the river where there is no bridge.

328. ROCHEPORT (BOONE) CAVE

Boone County, 3 miles southeast of Rocheport, near common east corner of secs. 17 and 20, T. 48 N., R. 14 W., Rocheport 7½-minute Quadrangle.

Bretz (1956, p. 288-289) describes this 0.7 mile-long tunnel cave. Several square miles drain into the upper end via Sinking Creek; thus caution should be used in exploring this cave during the rainy season. Bretz describes much debris, including huge logs, brought in from the upper entrance. Vineyard and Feder (1974, p. 249-253) discuss this area as related to Lewis and Clark Spring.

Rocheport Cave enjoyed a brief flash of fame in the late-1960's when it was opened to the public as Lewis and Clark Cave. Venerable Chief Red Fox pitched his tepee near the cave entrance and greeted visitors for some months. Lucky tourists also got an opportunity to ride The Big Muddy on a replica of a keelboat used by frontiersmen. However, neither Chief Red Fox nor the keelboat could keep the venture afloat in the financial seas. The cave was reopened, though, in the late 1980's under new ownership.

The thoughtful tunnel caver will want to see the impressive upper, or swallow hole, entrance as well as the spectacular lower portal of Rocheport Cave. Sinking Creek is entirely swallowed in a sinkhole over 100 feet deep, graced by giant trees rooted in the jumble of collapsed cavern rock in the bottom of the sinkhole.

329. RAILROAD CAVE

Pulaski County, 3 miles northwest of Waynesville, on west side of Gasconade River, near center NE¼ SE¼ NW¼ sec. 10, T. 36 N., R. 12 W., Waynesville 7½-minute Quadrangle.

Bretz (1956, p. 415-417) describes this cave as 1,680 feet long. It is relatively near the crest of the ridge it penetrates and does not act as a conduit for any appreciable amount of modern drainage. A more thorough description with a detailed map was published by Johnson (1964).

330. BLUE SPRING NATURAL TUNNEL

Christian County, on east side of James River, 2 miles southeast of Battlefield, in center of SW¼ NW¼ sec. 33, T. 28 N., R. 22 W., Nixa 7½-minute Quadrangle.

The upper entrance to this tunnel is in an elongated northeast-trending sink which receives the flow in Saunders Valley. According to Vineyard (1973b), the tunnel can be followed to a sink which perforates the ceiling. This ceiling perforation is shown as very small depression contours 70 yards northwest of the large entrance. Flow into this tunnel emerges at Blue Spring 0.3 mile northwest of the perforation (Vineyard and Feder, 1974, p. 215-219).

331. DUCHIEN CAVE NATURAL TUNNEL

Pike County, 3 miles southeast of Frankford, in Ranacker State Wildlife Area, in NW¼ SE¼ NW¼ sec. 24, T. 54 N., R. 4 W., Frankford 7½-minute Quadrangle.

Myers (1963, p. 36) describes DuChien (which he spelled DuChein) Cave as a tunnel approximately 175 feet long which penetrates a hill. The lower entrance is reported to be 6 feet high and 45 feet wide and the upper entrance the same height but less than 20 feet wide. His accompanying map suggests that this tunnel would involve some crawling and that lights should be used for traversing it.

The Frankford topographic sheet shows an interrupted drainage in an unnamed hollow, with a closed, hachured contour on the upstream side.

332. MOON VALLEY SHELTER CAVE

Christian County, 4 miles southeast of Selmore, on tributary to Woods Fork, in NW¼ NW¼ NE¼ sec. 35, T. 26 N., R. 21 W., Selmore 7½-minute Quadrangle.

Martin (1972, p. 17-19) describes this cave in Cotter Dolomite as having *"...two entrances approximately 4 feet high and 10 feet wide."*

His map depicts it as a natural tunnel 50 feet long and trending north-south.

333. CLOISTER NATURAL TUNNEL

St. Clair County, 9 miles southwest of Collins, in bluff on north side of Haynie Branch, near center SW¼ NE¼ NW¼ sec. 26, T. 36 N., R. 26 W., Caplinger Mills 7½-minute Quadrangle.

Cloister Natural Tunnel is so-named because it is a natural tunnel paralleling a sandstone bluff face and is flanked by solid rock on the bluff side but by arched, cloister-like openings on the valley side. The tunnel is 20 feet long, 5 feet wide, and 6 feet high at the southeast end, narrowing to 2 to 3 feet in diameter at the northwest end. The tunnel trends N 60° W, parallel to the bluff, and is in the lower part of the bluff where it begins a re-entrant to form the first south-draining ravine west of Panther Den Hollow. The sandstone bluff is Pennsylvanian in age and beds below the tunnel are conspicuously cross-bedded with bedding dipping to the northwest. The tunnel undoubtedly owes its existence to unequal weathering in sandstone of varying resistance combined with accelerated weathering along fractures.

Although the tunnel is not large, it is unusual in that one side is perforated by the cloister arches and it could make a good subject for photography. Directions for reaching it are not easily given and the best navigational aids would be the Caplinger Mills Quadrangle and directions provided previously to the parking area for the Haynie Branch Natural Bridges (No. 300). From that parking area, strike off on foot westward into Haynie Branch with one eye on the map and the other counting the ravines coming in from the right.

334. PERKINS CREEK NATURAL TUNNEL

Bollinger County, approximately 2 miles northwest of Zalma, in or near sec. 18, T. 29 N., R. 9 E., Zalma 7½-minute Quadrangle.

Dr. Gene VanMatre of the University of Missouri-Rolla faculty kindly supplied information on the location of this tunnel. According to him, Perkins Creek takes a short cut through a rock spur, having abandoned its former course around the tip of the spur. He reports that the tunnel is essentially water-filled and probably is not generally traversable. The site is to the west of Highway H and is reported to be on or near the Howard Wycoff farm.

The topography in sec. 18 and the adjacent sections to the south (secs. 19 and 24) and west (sec. 13) is extremely complex, with "moccasin bends" in Perkins Creek creating two pronounced "narrows," and a third (center sec. 19) formed by Perkins Creek and Castor River. The southeast quarter of sec. 13 is occupied by a nearly round depression called Cypress Pond, possibly a former sinkhole, its drainage now closed and the 160-acre depression partly filled by a cypress swamp.

335. OPEN-END CAVE NATURAL TUNNEL

Ozark County, 3 miles east of Dora, in west bluff of North Fork River, in NW¼ NE¼ sec. 10, T. 24 N., R. 11 E., Dora 7½-minute Quadrangle.

The following is from Brichetto (1975):

"There are two entrances to this 'cave,' one on the northwest side of bluff which is 20' high by 11' wide, the other faces east. This goes into a room 15' long by 10' wide.......there is another level which is a 7' square room; on the east side of this room, there is a 3' diameter hole which opens onto the face of the bluff which overlooks the river 175' below. An incredible view can be seen from this 3' opening both up and down the river."

336. BIG CREEK CAVE

Shannon County, 5 miles southeast of Round Spring, in NW¼ SE¼ sec. 36, T. 30 N., R. 4 W., Eminence 7½-minute Quadrangle.

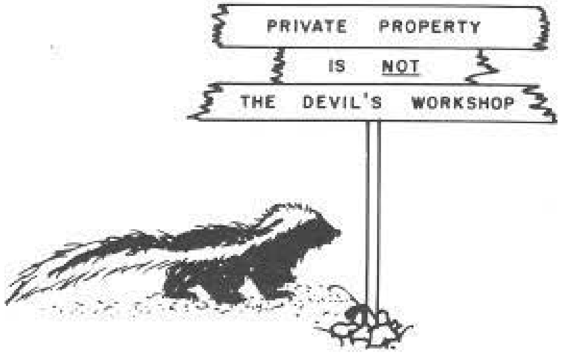
Bridge (1930, p. 44) says:

"On the north side of Current River in Sec. 36, T. 30 N., R. 4 W., is a cave which consists of a large arched recess beneath an overhanging cliff. At the back of this recess are two narrow passages, one of which is said to extend through the hill and come out on Big Creek. The passages are low and narrow and were not explored."

337. NATURAL TUNNEL

Goodspeed (1888, p. 213) describes a natural tunnel or double-entrance cave in Franklin County as follows:

"Persimmon Gap is due south from Stanton about three miles. A spur of the mountain comes down to a bend of the river, and some distance back from the point a straight hole, from ten to fifteen feet wide, passes clear through the point, about one-fourth of a mile in length."



COMPLEX KARST SITES

338. GRAND GULF

Oregon County, Grand Gulf State Park, 6 miles west of Thayer, near terminus of Highway W, in S½ sec. 20 and N½ sec. 29, T. 22 N., R. 6 W., Koshkonong 7½-minute Quadrangle.

Caves are like houses — given sufficient time and insufficient maintenance, the roof may fall in. Grand Gulf State Park, 6 miles west of Thayer, is a spectacular example of such a cave, with scenic results unrivaled in the Midwest. The bit of roof remaining forms one of the largest of the many natural bridges in Missouri. These features, combined with an underground stream and a dastardly example of stream piracy, still leave me awe stricken, even though I have contrarily resolved to be unimpressed by rave notices (fig. 145).

The road into Grand Gulf and to the parking area continues almost straight ahead as a trail which crosses the natural bridge spanning the Gulf. Those walking downslope onto the bridge may look to the left and see the canyon with 130-foot high vertical walls. On the right of the bridge is the terminus of the canyon where a wet-weather stream, after having passed under the bridge, emerges briefly into a bluff-encircled chasm and then disappears into a cave, the remaining portion of the once greater cave system before the roof failed.

The fork in the canyon to the left or west of the bridge is formed by the converging of two major ruined caves. The more northerly fork has a watershed area of approximately 24 square miles, the south fork about 2 square miles. The north or main fork is Bussell Branch which at one time flowed on top of the then-concealed cave system at the Gulf and continued southeastward into Arkansas as what is now English Creek. This original drainage system is conspicuous from the air and also on the Koshkonong topographic map. When the cave roof fell in, Bussell Branch went underground at the west terminus of the Gulf — a case of subterranean stream piracy. Such piracy of streams by underground drainage systems is not rare, but the Grand Gulf drainage system represents the greatest booty of any Stygian pirate in the Ozarks, and the battle area records the most extensive, dramatic, and scenic preservation of geological conflict in Missouri. Owen (1898, p. 82-86 of reprint) and Bretz (1956, p. 350-355) have thoroughly described the geologic setting and history of Grand Gulf and their publications are required reading for the serious student of geology visiting the area.

Although the total surface drainage area of Grand Gulf is 26 square miles, the headwater portion of this area is perforated with sinkholes, and some of the flow in this area undoubtedly

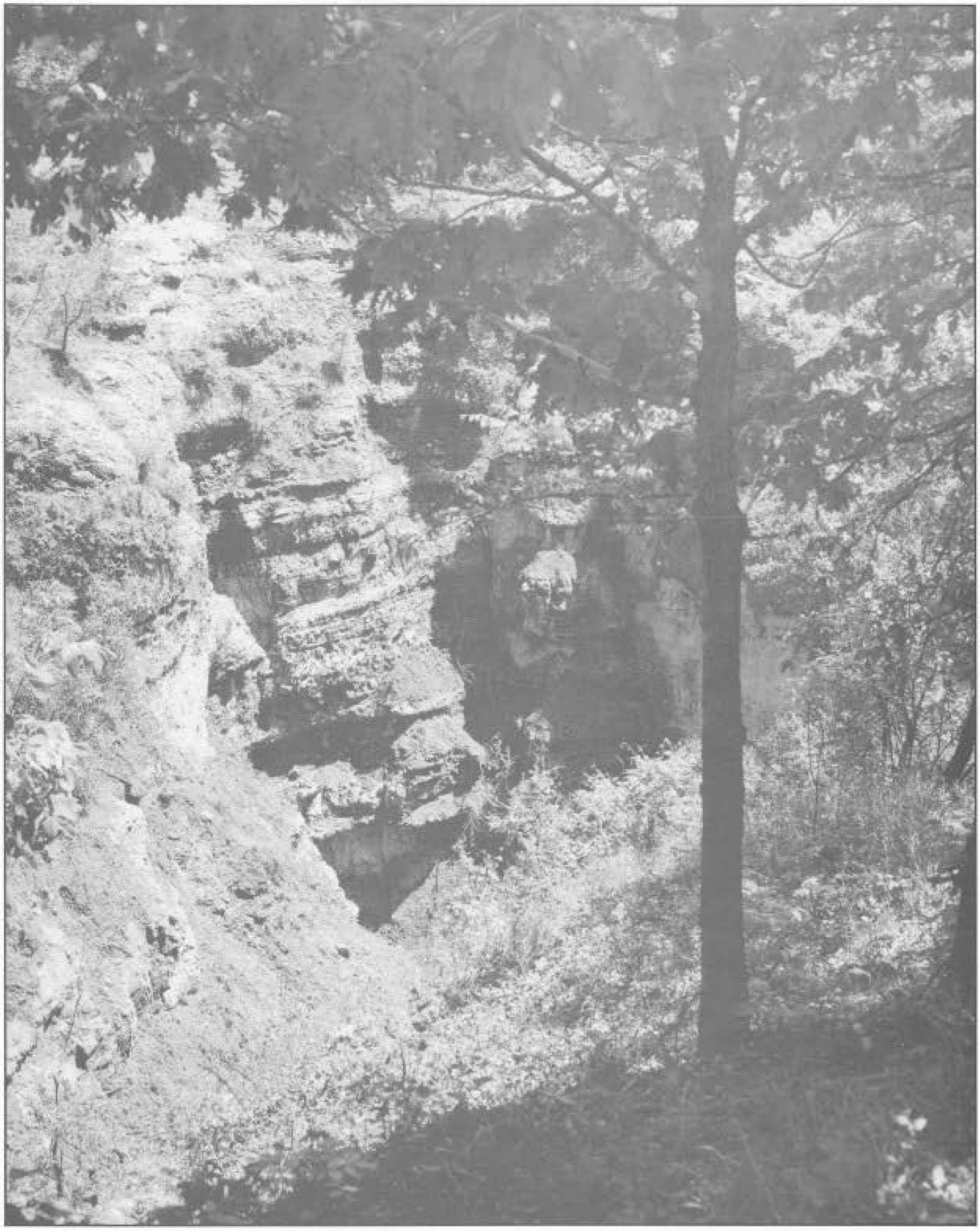


Figure 145

Grand Gulf. Photo by Gerald Massie.

goes underground in its infancy. Despite this loss, the volume of water entering the Gulf during rainy seasons and ultimately disappearing into the cave beyond the natural bridge is tremendous. This disappearance is of interest to chauvinistic Missourians because of competition with Arkansas regarding claim to the largest single-outlet spring in the United States. Big Spring, near Van Buren, Missouri holds this honor with an average flow of 276 million gallons per day. Mammoth Spring, Arkansas, across the state line from Thayer, Missouri, offers some competition but ranks between Big Spring and Greer Spring (Vineyard and Feder, 1974, p. 71).

Toney Aid demonstrated the connection between Grand Gulf and Mammoth Spring by using Uranine Soluble, a fluorescein dye. This was introduced at the mouth of the cave draining Grand Gulf and was detected by activated charcoal filters at Mammoth Spring. Aid describes the introduction of the dye in the fall of 1967 and the results as follows (1967):

"On the night of October 16, after a day-long rain, I descended into Grand Gulf and placed one-half pound of the dye into water flowing into the mouth of the cavern. The flow of water at that time amounted to a small, rapidly moving stream approximately 3 feet wide and 3 inches deep, but it was apparent that the flow had been 2 to 3 feet deep and much wider in the day.

"From these results we can conclude that the dyed water first appeared at Mammoth Spring in a low concentration on October 17, approximately 24 hours after it had entered Grand Gulf. The dye concentration kept increasing until it reached a peak on October 20 and then fell in concentration until on October 23 all traces of it had disappeared. These facts proved that the water flowing into Grand Gulf does emerge at Mammoth Spring. They also show that the nine miles between Grand Gulf and Mammoth Spring were covered in between 24 and 96 hours time or a total time of four days."

Vineyard and Feder (1974, p. 71-72, and fig. 25, p. 77) summarize the relationships between Grand Gulf and Mammoth Spring and give us an aerial view of the Gulf.

The canyon may be entered by taking Canyon Trail as shown on figure 146. This trail enters a steep gully and enters the south fork of the canyon near its head. Those reaching the bottom of this fork, may wish to go left to the abrupt head where a spring and associated small cave, as well as a wet-weather waterfall, merit the detour. I am cautious about drinking from strange springs, but my mysophobic tendencies vanish and my immunity to typhus increases when the temperature exceeds 95 degrees.

The head of this fork was probably at one time a sinkhole — a condition suggested by its cylindrical form as viewed from above. Enlargement of the fractures or joints beneath the surface by solution may produce caves. If a cave roof collapses locally, or if a near-surface vertical joint is enlarged by solution of the rock, a sinkhole results. Grand Gulf may be thought of as a system of elongated sinks, one canyon of which terminates at its head in the more common circular sink.

Those following the south canyon downstream must climb over huge blocks of dolomite representing ruins of the collapsed roof. At the junction of the south canyon with the main canyon, a rock and debris pile to the right offers a good spot for photographing the natural bridge. The Needles Eye is a natural perforation in rock near the tip of the divide between the two canyons.

The entrance to the bridge is about 75 feet high by 50 feet wide but narrows to 10 feet in diameter at the downstream end. Exploring this tunnel requires boots or high shoes — the muck left by past floods is deep and treacherous. The tunnel is approximately 250 feet long and angles as it follows vertical joints enlarged by solution. Another mass of dolomite blocks from the collapsed roof, one of which contains fossil ripple marks, is to the right when emerging from the tunnel. A sharp bend around these ruins leads to a frog-filled muck pond and the entrance to the cave where Bussell Branch goes underground for the start of its trip to Mammoth Spring.

Ward and Senn (1973) have compiled a wealth of material on Grand Gulf and its cousin

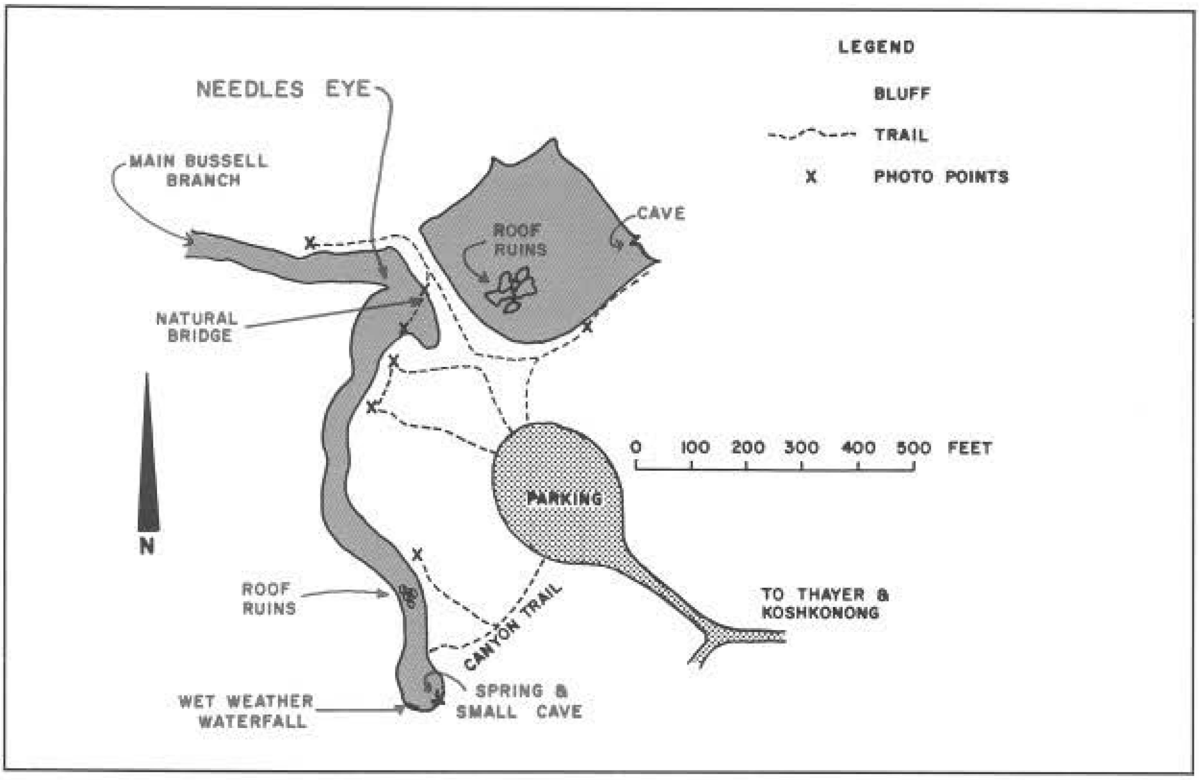

LEGEND
BLUFF
TRAIL
X PHOTO POINTS
NEEDLES EYE
MAIN BUSSELL BRANCH
ROOF RUINS
CAVE
NATURAL BRIDGE
0 100 200 300 400 500 FEET
PARKING
N
ROOF RUINS
CANYON TRAIL
TO THAYER & KOSHKONONG
WET WEATHER WATERFALL
SPRING & SMALL CAVE

Figure 146

Sketch map of Grand Gulf area.

(9-miles-removed), Mammoth Spring, Arkansas. In their description of Grand Gulf (p. 40-41) they quote from a newspaper account of the visitation as follows:

"If the old-timers are correct in their belief regarding the tornado of the early 1920's, which partially filled the Gulf cave with debris, the following detailed account of the cave before this blockage occurred is doubly interesting. This account of the cave was uncovered in 1971 in the microfilm collection at the State Historical Society of Missouri at Columbia. The article was printed in the West Plains Gazette and reprinted in the Current Wave, Eminence, Shannon County, Missouri, November 26, 1884:

"On Tuesday, October 28, 1884, a representative of the West Plains Gazette for the first time visited what is known by the various names of The Grand Gulf, the Twin Sinks, and the Gulf Cave, that being the day set by Major M.G. Norman of Alton, Missouri, its owner, for an exploration of this great and awe-inspiring phenomena of nature.

"To give anything like a comprehensive description of this stupendous wonder, whether by voice or with pen, is quite a difficult matter, for like Niagara Falls, nothing short of ocular inspection will give one a realization of its remarkable character or its immensity."

After describing the general appearance of the Gulf, their description continues:

"Nearly opposite the opening or arch which forms the bridge, and on the lower or northeast side of the canyon that makes in from the east, is the mouth of the great Gulf cave. Standing at the mouth of this cave the visitor is at the deepest point of all these canyons. The mouth is some 40 feet in diameter each way and the visitor on entering passes down an incline of some twenty feet to the hundred, the orifice narrowing up as he proceeds. After proceeding

some 200 feet, there is a right-angle turn to the left, following which and still descending, for some 50 feet comes another to the right, and the opening is such that one is compelled to stoop. Proceeding this last turn some 40 or 50 feet more, one comes to a big spring of clear and very cold water, that crosses the passage from right to left. At this point, Major Norman was obliged to blast away the rock to make an opening sufficiently large enough to introduce his exploring boat, though previously the few visitors that had dared enter the place had squeezed through on hands and knees. At a distance of 100 yards from the mouth of the cave and at the end of this narrow passage, the visitor comes to a literal lake of water. Projectiles thrown in any direction save directly behind, will not strike anything but water.

"The research made on the day of our visit was by two men in the boat. Aided by lights left at the place of entrance by which to return, and taking lights with them, they started in on a voyage that but few men would have the nerve to make, for as it is certain that immense volumes of water find their way into this cave, it is equally certain that there is somewhere an outlet and of course, a current leading to it. Beside the danger of being drawn imperceptibly away, there is the additional risk of meeting with whirlpools, where the waters may descend to caves of greater depth and of sudden falls of water. In fact, the sound of falling water is heard, seemingly from a great distance.

"Cautiously proceeding, the explorers, at a distance they judged to be 200 yards, came to a bank or high ridge, projecting above the surface of the water. Through this they were not able to find an opening, but clambering over it, one of them came to the shore on the other side and there found a continuation of water and an expanse so great that with all his efforts, he could project a stone only to hear it plunge into the watery depths. From indications it was believed that they had only entered a side chamber of the cavern and that the great main chamber lays in a different direction."

Owen (1898, p. 95-102 of reprint) describes her exploration of this cave as follows:

"Relieving ourselves of all superfluous burdens just within the cave entrance, we lighted candles and sat down to wait for our eyes to adjust themselves to the changed conditions, from brilliant sunlight to absolute darkness, broken only by the feeble strength of three candles. It was noticeable that in the moist atmosphere of the Missouri caves, three candles were not more than equal to one in the dry caves of South Dakota.

"Very soon we were able to continue the inspection of our surroundings, and the large passage we were in would more properly be called a long chamber of irregular width but averaging about thirty feet. This ends abruptly nearly five hundred feet from the entrance, but a small passage scarcely more than six feet high runs off at right angles, and into this we turn. It is not quite so nearly dry as the outer chamber, and at a distance of less than one hundred feet we suddenly come to the end of dry land at an elbow of the silently flowing river whose channel we had almost stepped into. The ceiling dipped so we were not able to stand straight, and the guide said he had never gone farther; but to his surprise here was a light boat which I am ready to admit he displayed no eagerness to appropriate to his own use, and swimming about it close to shore, were numerous small eyeless fish, pure white and perfectly fearless; the first I had ever seen, and little beauties.

"By burning magnesium ribbon we saw that the passage before us was a low arch and occupied from wall to wall by water, the direction of the flow being into another of somewhat great size at right angles to that by which we had come, and at the mouth of this lay the boat. The distance we could see in either direction was of tantalizing shortness, and the boat was provided with no means of guidance or control, save an abundance of slender twine which secured it to a log of drift from the outside; so I decided to leave my companions in charge of the main coil of twine, while I went on an excursion alone, there being not much evident cause for apprehension as no living cow could ever have made the trip to this favored spot.

"Although the water looked perfectly placid, the boat drifted with surprising speed, so that the two scared faces peering after me were soon lost sight of. The channel was nowhere more than six feet wide, consequently as the

boat inclined to drive against either wall I was able with care to keep it off the rocks with my hands, and in the same way guide it around the sharp turns in safety. After several of these turns there appeared the mouth of a passage so much smaller that the roof was only twelve inches above the sides of the boat and I could touch both walls at the same time. By running the boat across this it was held in place by the current, and I could sit at ease and enjoy the position, which even the least imaginative person can readily conceive to have been a novel one.

"The small eyeless fish had been noticeable in the water everywhere but now came swimming about the boat in an astonishing multitude, and as unconscious of any possible danger as bees in a flower garden. Having no eyes, they were naturally undisturbed by the light, so the candle could be held close to the water for a satisfactory examination of the happy creatures.

"They bore a striking resemblance to minnows, although a few were larger, and it is claimed that four or five inches are sizes not unusual, but they happened not to be on exhibition. Even dipping a hand into the water in their midst occasioned no alarm, and they might have been caught by dozens.

"The guide now loudly called that he had fears of the twine being cut on the sharp edges of rock and that cutting off all possibility of the boat's return, which being sufficiently reasonable, explorations were indefinitely suspended, and a landing soon made. The camera and flash-light were then prepared for taking a view, and a point of light being needed to work by the nephew was asked to sit in the boat with his candle, to which he readily consented; but judging from the developed picture it may be doubted if his pleasure at the time was extremely keen.

"On leaving the cave the guide said it would be necessary to return to the upper end of the Gulf in order to reach the surface, as the ascent could be made in another place; and leading the way to the left of the entrance he started up the nearly perpendicular wall, more than two hundred feet high, by a sort of 'blind trail' that would have caused a mountain sheep to sigh for wings, but it was very beautiful."

Grand Gulf is not easy to photograph and dreams of a helicopter or skyhook and a 180-degree lens are certain to come to mind while searching for the ideal camera angle. The map (fig. 146) shows paths to promontories along the rim of the canyon from which to photograph the chasm and natural bridge. The best shot of the bridge is from within the canyon looking downstream to the southeast.

Grand Gulf (fig. 147) is formed in the Jefferson City Dolomite, the same unit which forms bluffs at the capitol city. Although this formation was deposited in seas which covered much of the Ozarks some 480 million years ago, the date of formation of the Grand Gulf cave system may be as young as one or two million years and the roof collapse and piracy may date back only a few thousand years.

Rayburn (1941, p. 314-316) says:

"The climax of tall tales in the Ozarks is found in the romantic legend of Grand Gulf. This story is seasoned with some archaeological approval but it is my opinion that actual proof is as far away as the millennium. It is interesting folklore, but not to be taken too seriously. I summarize the tale as reported in the Thayer, Missouri, News eight or nine years ago.

"Grand Gulf begins with a canyon a few miles north of the Missouri-Arkansas line in Oregon County, Missouri, which carries a fair-sized stream of water. The stream disappears into a subterranean cavern. A few miles below in Arkansas is the famous Mammoth Spring which is a small river rising from the bowels of the earth. It is an established fact that the gulf and the spring are connected. Tests have been made by emptying sacks of oats into the stream in the canyon and observing the grains emerge in the spring. A lost river, born in Missouri, reborn in Arkansas.

"The fantastic part of this narrative is the legend associated with Grand Gulf. Someone at some time conceived the idea that Job and his herdsmen pitched their tents and fattened their herds in the vicinity of the lost river. This was the land of Uz spoken of in the Old Testament. Job's eldest son lived near him and had his habitation destroyed by the first tornado mentioned in the Bible (Job 1:19).

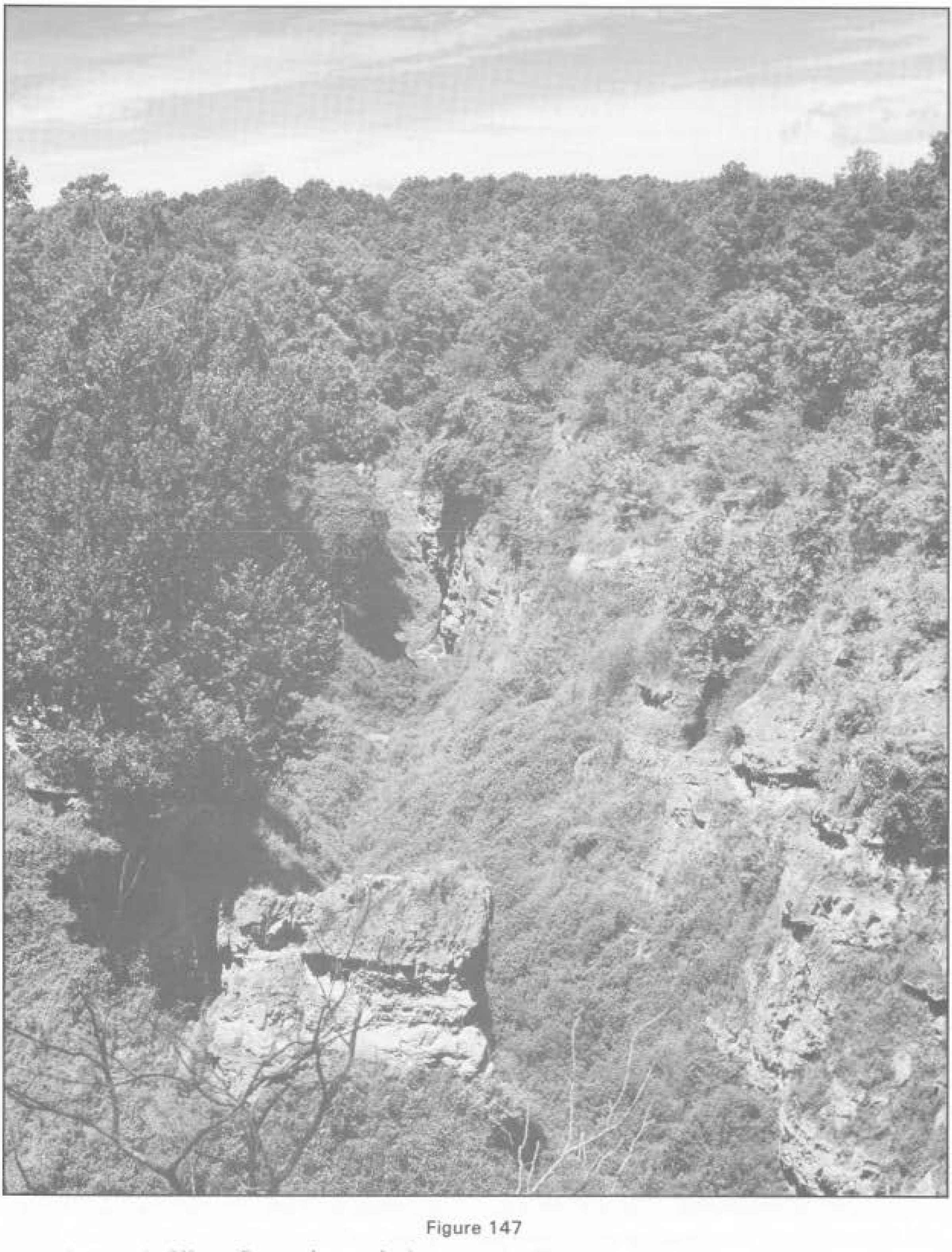


Figure 147

Grand Gulf may be Missouri's most impressive karst complex. Photo by Walker, Missouri Tourism Commission.

"Years after Job recovered from his boils, the land of Uz gained a remarkable civilization. They had fields and livestock and were not nomadic like the American Indians. The legend asserts that they traveled by boat up and down the stream in Grand Gulf which connected two important villages. (The legend doesn't explain how they emerged at the spring-end of the route).

"After a long time, the inhabitants of pastoral Uz were attacked by powerful bands of savages from the far north. It was a massacre with village after village being destroyed. Several people escaped immediate death by taking refuge in Grand Gulf, but the savages discovered their hiding place and rolled stones into the outlet at the spring, flooding the great cavern. Only a few escaped this horrible catastrophe. It is claimed that ancient hieroglyphics have been found, carved in copper and stone, telling the story of this great conflict.

"About thirty years ago two Missourians tried to explore the underground river in the Grand Gulf, but failed. They traveled by boat down the long canyon to the mouth of the cavern where the river sinks. They made their way underground for some distance, but turned back when passage became impossible. They found an old landing place in perfect condition and brought back an earthen jar estimated to be three thousand years old. The site of what is thought to be an ancient village has been found not far from Grand Gulf. These recent discoveries will probably spur the archaeologists on to greater action, but I cannot accept this land of Uz business."

In 1970, Leo A. Drey purchased Grand Gulf as an aquisition of the L.A.D. Foundation, to make it available to the general public. In 1984, the Foundation leased the property to the Missouri Departmant of Natural Resources, and it became Grand Gulf State Park. Overlooks, trails, and interpretive signs highlight the remarkable karst phenomena. An attempt is planned to reopen the lost cave and the underground river, last seen by Luella Owen.

Grand Gulf is easily reached by following Highway W west from Thayer for 5.4 miles to a crossroads, then continuing straight ahead, up a hill, to the parking area on the right. Those with a county road map or topographic map may wish to travel a scenic route on gravelled roads going through sinkhole country via Koshkonong.

339. HAHATONKA AREA

Camden County, Ha Ha Tonka State Park, 3 miles southwest of Camdenton, in secs. 1 and 2, T. 37 N., R. 17 W., Lake Niangua 7½-minute Quadrangle.

Ha Ha Tonka State Park area (fig. 148) is Missouri's most outstanding for containing a maximum of both geologic and human history combined in an area of less than 1 square mile. Bretz (1956, p. 123-132) stays in the superlative throughout his description of the relationship of the cave system, spring, chasms, sinkholes, and natural bridges in the area and any teacher of technical exposition would find his description worthy of study and exemplary use. His work is ably supplemented by Weaver (1970, p. 24-33 and 1974b, p. 86-92) who did historical research and published photos of man-made features and the environs of Hahatonka from long before impoundment of the Lake of the Ozarks.

Geologically the Hahatonka area is a classic example of collapse structures in a karst area and the close kinship of the common karst features is no better demonstrated in any other area of Missouri. Where collapse has not spread ruin, there are cave systems; where the cave system is filled with water and breached by surface erosion, there is a major spring. Where a cave system has collapsed *in toto,* there are chasms and sinkholes as well as the tumbled ruins of collapse rock. Where the collapse has been incomplete, a natural bridge is preserved. Steep bluffs mark the remaining walls of a collapsed cave system.

Hahatonka (formerly Gunter) Spring was one of the first attractions to lure humans to the area. Weaver cites the use of the enormous sinkhole southwest of the natural bridge by local Indian tribes for pow-wows and the wintering of prairie Indians from Minnesota at Hahatonka as well as visitations to the Great Spring by the Tetons. He cites references which state that Daniel Boone and his son Nathan visited the area in 1801, following the Niangua

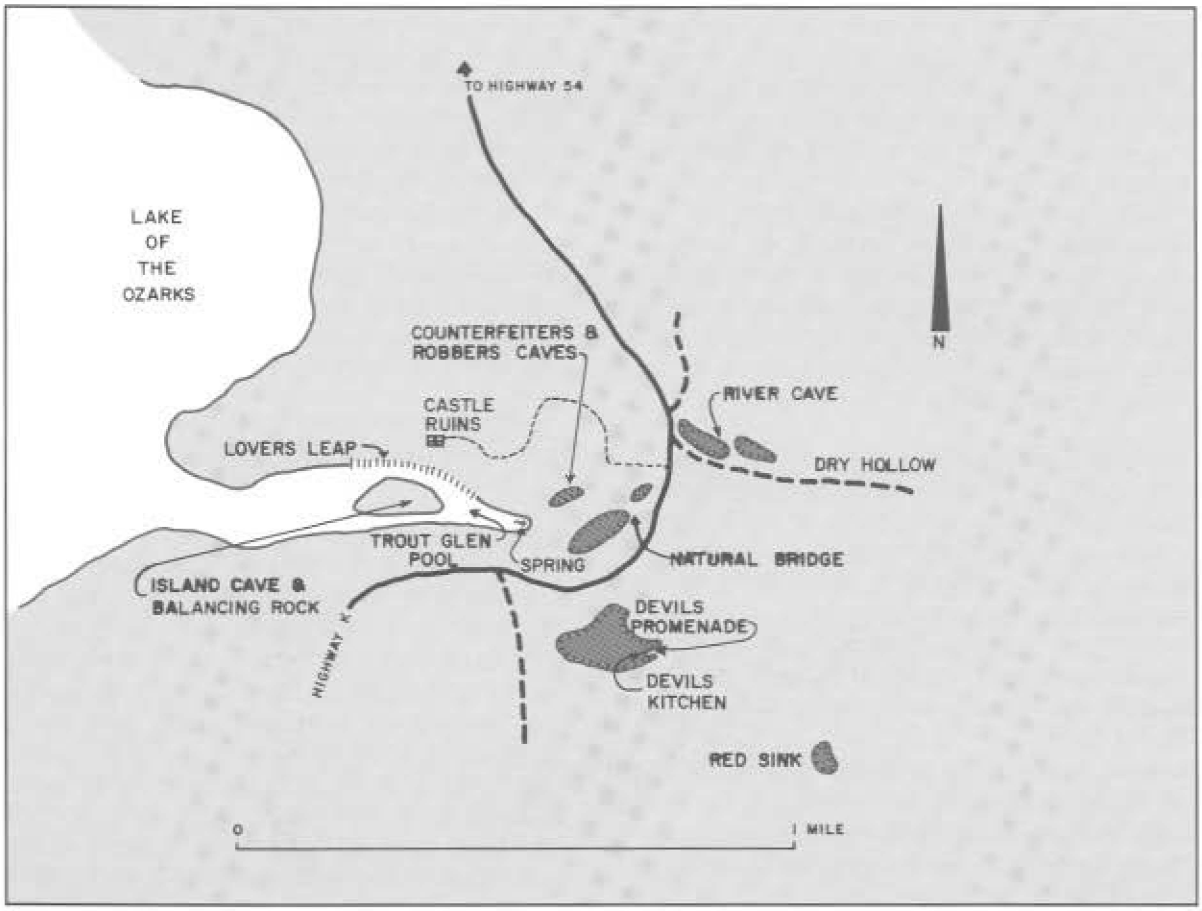

TO HIGHWAY 54
LAKE OF THE OZARKS
N
COUNTERFEITERS & ROBBERS CAVES
CASTLE RUINS
RIVER CAVE
LOVERS LEAP
DRY HOLLOW
TROUT GLEN POOL
SPRING
NATURAL BRIDGE
ISLAND CAVE & BALANCING ROCK
HIGHWAY K
DEVILS PROMENADE
DEVILS KITCHEN
RED SINK
0
1 MILE

Figure 148

Hahatonka area, Camden County.

drainage to the "Great Springs." Reportedly, their first winter's catch of pelts was confiscated by the Osages and the Boones returned in 1802 where they retained their pelts by "secreting them in the caves of the area."

In 1805 Meriwether Lewis of the Lewis and Clark expedition described the boundaries of the Osage territories and demonstrated a familiarity with the area, and Lieutenant Wilkerson of the Pike expedition explored the area. Weaver (1970, p. 30) cites a reference which says:

> *"The following year (1806) President Jefferson sent a messenger to the Osages who were assembled at the Big Spring on the Yunger, to notify them of his purchase of the territory."*

Weaver described the era starting in 1830 as the "outlaw era" when a grist mill was built as a front for robbing and counterfeiting activities. A local vigilance committee of citizens calling themselves "The Slickers" was organized to combat the outlaw band and warfare between the two groups lasted into the early-1830's. Although the grist mill is long gone, memory of the outlaws is preserved in the names of Counterfeiters Cave and Robbers Cave.

In 1903 Robert M. Snyder, a wealthy Kansas Citian, visited the Hahatonka area on a fishing expedition and was captivated by its beauty. In 1904 he began to buy land in the area, ultimately owning 3,500 acres (Butts, 1970). Construction of the mansion now known as the Hahatonka Castle began in 1905 using stonemasons from

Scotland and stone quarried from about 0.25 mile away. He did not live to see completion of the castle, for on October 27 of that year a boy on a coaster wagon cut in front of his car on Independence Boulevard and both he and the boy were killed when the chauffeur swerved in a futile attempt to avoid an accident (Yoest, 1968). At that time the castle was almost completed, but never reached the stage of completion he had planned. It stood idle for over a decade after the accident and was later finished sufficiently to be used by the family who retained it as a summer home and later rented it as a summer resort hotel.

In 1942 wooden shingles on the roof of the "fireproof" building caught fire and the castle burned. Following many years of semicommercialization and general neglect, the Hahatonka property was aquired by the Department of Natural Resources to become Ha Ha Tonka State Park (note variance in spelling). The impressive karst features of the park have been designated a State Natural Area.

Those visiting the area for the first time are probably most struck by the ruins of the castle surmounting a sheer 250-foot cliff which represents one of the most impressive Lovers Leaps (No. 139) in Missouri. The spring, with an average flow of 48,000,000 gallons a day, has lost some of its charm because of impoundment, but River Island Trout Glen and the bluffs at the castle blend to create exceptionally spectacular scenery.

The road to the castle from Highway D passes near the natural bridge, the upper part of which is the Gunter Sandstone Member of the Gasconade Dolomite, and the lower part Eminence Dolomite. The bridge has a span of 60 feet, a ceiling height of 13 feet, and a width of about 70 feet at the base which narrows to a convenient dimension for a one-lane road on the top, once used for access to the castle. Approximately 45 feet of rock forms the roof of the bridge and a sufficient safety factor has been incorporated to assure that the bridge will stand for many hundreds of years. Sinkholes above and below the bridge, as well as River Cave to the northeast, testify that the bridge is a remnant of a collapsed cavern system (fig. 149).

The sinkhole immediately below the bridge is designated on some maps as The Colosseum, a semantic incongruity in light of its use by the Indians as a meeting place. The extent of the cave collapse system in the Hahatonka area is further demonstrated by the ruins of dolomite associated with River Island and the Great Gulf which the island occupies. Bretz has so thoroughly described the relationships of these collapse features that those interested should not fail to read his report. He also points out that the underground stream in River Cave is quite probably a feeder for the spring.

From the junction of Highways D and 54, 2 miles southwest of Camdenton, drive south for 2.25 miles to the Park entrance.

The area would best be visited in the winter when foliage is at a minimum to enjoy some of the variety of features as shown in figure 148. The sinkhole on the south side of Highway D contains a scenic walkway rim and ramp which shows definite evidence of having been used by the Devil as a promenade, and a cave with a vertical slot which forms the Devils Kitchen (No. 323). Red Sink (No. 222), a bit farther to the southeast, is mentioned by Ross (1905, p. 69-70) as having been used by "free booters" as a corral for their horses in 1845. Bretz (1956, p. 132) summarizes an impression of the Hahatonka area as follows:

"Before our examination of the vicinity is complete, we should take the path to the northern summit of the clift hill. The gentle outer slopes and the precipitous inner slopes are strong in contrast. Below us lie the ruins of one of nature's constructions, the former Hahatonka Cave system. Alongside rise the fire gutted ruins of one of man's constructions, the former Hahatonka Castle and Tower. There, on the brink of the great north wall of the rift made by cave collapse, 240 feet above the lake's high level, are perched the white walls of the burned castle (fig. 61). The four, chimneyed and windowed, gable ends rise three stories high; spectral in any light, needing only ivy and a hooting owl to complete the picture of former greatness fallen to ruin."

An excellent bibliographic reference to Hahatonka and its history is Snyder (1975). He, as the

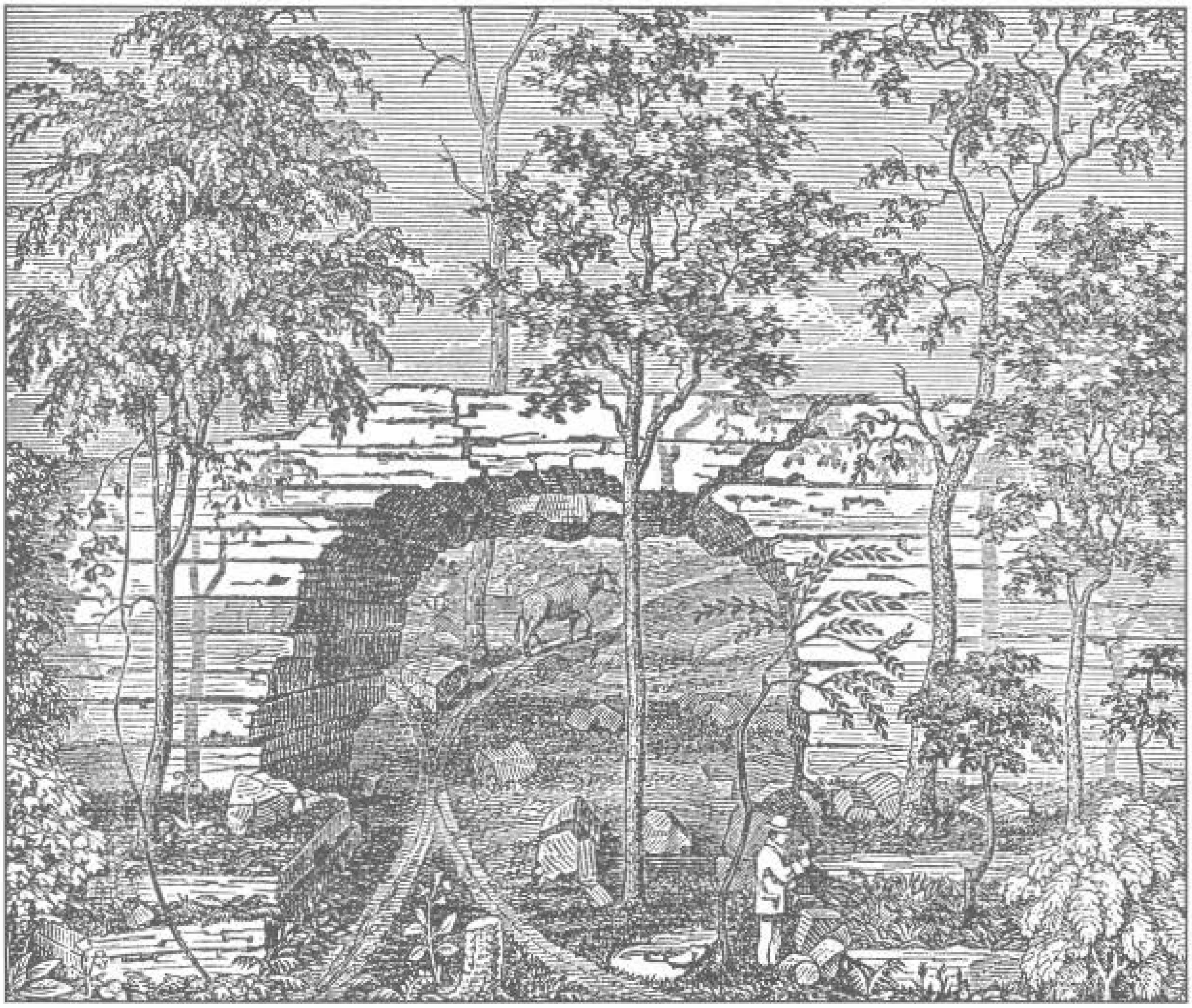


Figure 149

Natural bridge in the Hahatonka area, Camden County (from Swallow, 1855).

grandson of Robert Snyder, has given a comprehensive story with the advantage of family and personal background.

The 1982 edition of the Lake Niangua 7½-minute Quadrangle shows the Ha Ha Tonka (note variation in spelling; both the USGS and the Missouri Department of Natural Resources, Division of Parks now use the three-word form rather than the single-word used herein) area in considerable detail. Both a Black Sink and a Red Sink are shown, along with Devil's Kitchen, Natural Bridge, River Cave, Island Cave, ruins of the castle, and the spring. Robbers, Bear, and Counterfeiters Caves are also shown but not named. The high bluff on which the castle ruins sit is labeled Deers Leap Hill.

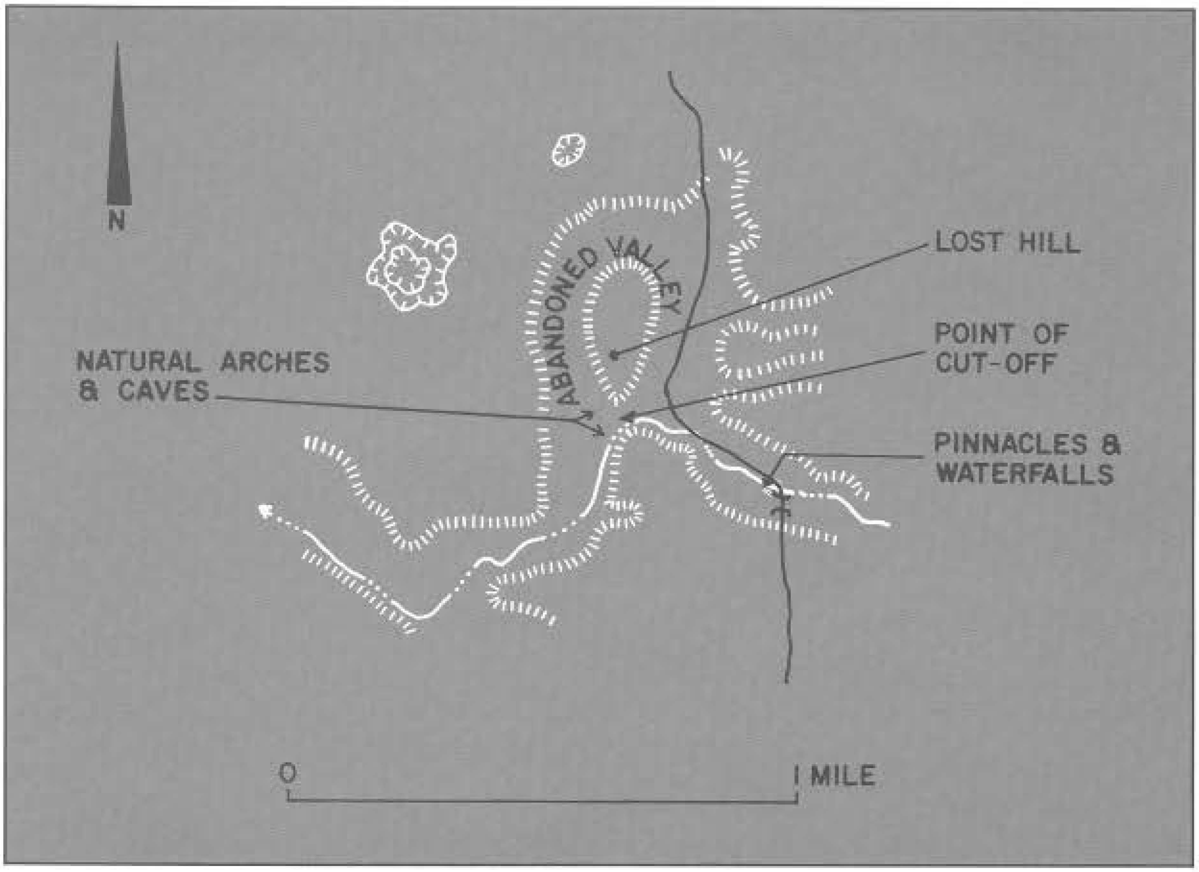

N
ABANDONED VALLEY
LOST HILL
POINT OF CUT-OFF
NATURAL ARCHES & CAVES
PINNACLES & WATERFALLS
0
1 MILE

Figure 150
Dry Sac Lost Hill Area near Springfield.

340. DRY SAC LOST HILL AREA

Greene County, between Fulbright Spring and McDaniel Lake, near north edge of Springfield, on South Dry Sac Creek, in E½ sec. 36, T. 30 N., R. 22 W., Ebenezer 7½-minute Quadrangle.

This area will eventually be urbanized and deserves serious consideration for development as a public park because within a radius of less than 0.5 mile it contains an abandoned entrenched meander loop, a lost hill, two natural arches, a tight crawl natural tunnel, several caves, and pinnacled limestone with a low waterfall.

ENTRENCHED MEANDER LOOP WITH CUTOFF

As shown on figure 150, Dry Sac formerly flowed north of its present route in a loop and shortened itself as it cut through the rock neck of this loop leaving behind an exceptionally impressive abandoned valley. This cutoff shortened the stream by approximately a mile and furnished some fertile bottomland which is most impressive on the north end of the abandoned loop. The lost hill in the center is more than 80 feet high in its southern half.

NATURAL ARCHES

At the south end of the lost hill, a natural arch, 6 to 7 feet high with a 2-foot ceiling and a span of approximately 5 feet, flanks the stream channel. One pier was surrounded by water at the time it was visited. Behind it and extending southwest is a natural tunnel about 15 feet long with a minimum diameter of approximately 2.5 feet which would be a magnet for crawling-bent children, especially those dressed in Sunday best. Farther back from the arch is a double cave containing a satellite shallow cavern in the floor of the entrance and small portals which admit light on the east side. Several other shallow caves are obvious in this same bluff, one of which has had extensive stonework in the past and suggests a cliff-top home of years ago.

On the south side of the stream where it cuts through the rock neck, a natural arch, 8 feet high, 8 feet wide, and with a ceiling 1 foot thick is near the upper part of the bluff. The arch, 4 to 5 feet wide, is flanked by joints trending N 60° E. Below the arch and a few feet to the southwest is a small cave with an entrance about 4 feet in diameter which curves to trend approximately the same direction as the joints forming the edge of the natural arch.

The profusion of caves, arches, fissures, and other solution features supports a surmise that Dry Sac may have originally penetrated the rock neck through a cave system. Prior to penetrating this neck thousands of years ago, it made the great loop around the east, north, and west sides of the lost hill. Breaching of the loop neck resulted in a shortening of 1 mile.

PINNACLES
(NE¼ NE¼ SE¼ SE¼ sec. 36)

A few yards downstream from the blacktop road (a north extension of Grant Avenue) which crosses South Dry Sac upstream from the cutoff, pinnacled and fissured limestone in the streambed forms a waterfall system with a total drop of about 5 feet. The fissures follow fractures (joints) trending N 50° E, and varying from 3 to 6 feet wide with a depth as great as 5 feet. The trend of these joints is closely parallel to that of fractures associated with the arch on the south bluff of the cutoff, suggesting a general northeast trend for the predominant fracture system of the immediate area.

All of these features are formed in the Burlington Limestone and would appeal to the photographer, picnicker, wader, climber, geologist, and an age group spanning many decades.

341. KASSEL CAVE NATURAL BRIDGES

Perry County, 2 miles northeast of Farrar, in southwest bluff of northwest-flowing tributary to Omete Creek, in SW¼ SE¼ SW¼ NW¼ sec. 24, T. 35 N., R. 12 E., Crosstown, Missouri-Illinois 7½-minute Quadrangle.

The Kassel Cave system is the state's most compact example of collapsed caves with resulting canyons and natural bridges. As shown on figure 151, four natural bridges are crowded into an area approximately 100 feet in diameter. The system is entered via a steep-walled portal in the south bluff of a tributary to Omete Creek. From the portal, bear right or northwest into the main canyon which is spanned by natural bridge no. 1, a remnant of the cave roof with a 20-foot span, a 12-foot ceiling, and a 4-foot minimum thickness near the center of the arch. The arch narrows to 6 feet in width near the center and is doomed to collapse within a few hundred years because of a fracture system crossing it parallel to the main canyon.

Natural bridge no. 2 has a ceiling height of 3 feet on the north side and 8 feet on the south with a maximum span of 12 feet, a length of 14 feet, and a 6-foot thick ceiling. Bridge no. 3 has a 17-foot span, a 10-foot high ceiling, and a passageway length of 30 feet. Bridge no. 4 is almost filled with debris and has a maximum ceiling height of 2 feet and a span of 8 feet.

The cave entrance at the southwest end of the system has an 8-foot ceiling with a width of 18 feet. It was not explored, but surface reconnaissance above the cave system revealed an east-west fissure system approximately 20 yards west of the cave entrance. The roar of flowing water could be heard at the fissures. These fissures represent another entrance to the cave and interrupt the roof sufficiently to make the lower part of the cave qualify as a natural tunnel if a fifth tunnel or bridge is needed to cinch the "Missouri Natural Bridge-Tunnel Concentration Grand Championship."

The system, in Plattin limestones, is scenic and fascinating and creates an impression of a ruined city. It also offers excellent opportunities for photography involving natural bridge no. 1 as one shot, and a view looking northeast from the cave entrance area through natural bridges nos. 3 and 2. Because of the variety of directions for photography, an overcast day would be the most ideal for shooting.

Fractures are the controlling factor in determination of this system, with one set trending west-northwest and another set north-northeast.

About 200 feet downstream from this system is a resurgence flowing from fissures in the same Plattin limestone. Sinkholes in the uplands and higher slopes to the south of the resurgence and collapsed canyon system feed water to these outlets. The visitation was made after and during fairly heavy rains and the spring was muddy, indicating its open channel surface connections.

The site was reached via the following route:

Miles	
0.0	*Town of Farrar. Drive northeast from east edge of town.*
0.85	*Road junction — turn left.*
1.45	*Bear right at T-junction.*
1.75	*Bear slightly to right at T-junction.*
2.70	*Kassel house on left. Park in farmyard and follow trail shown on topographic map northward to creek valley, then go down creek and through gate in fence. Portal to canyon is 250 feet west of gate.*

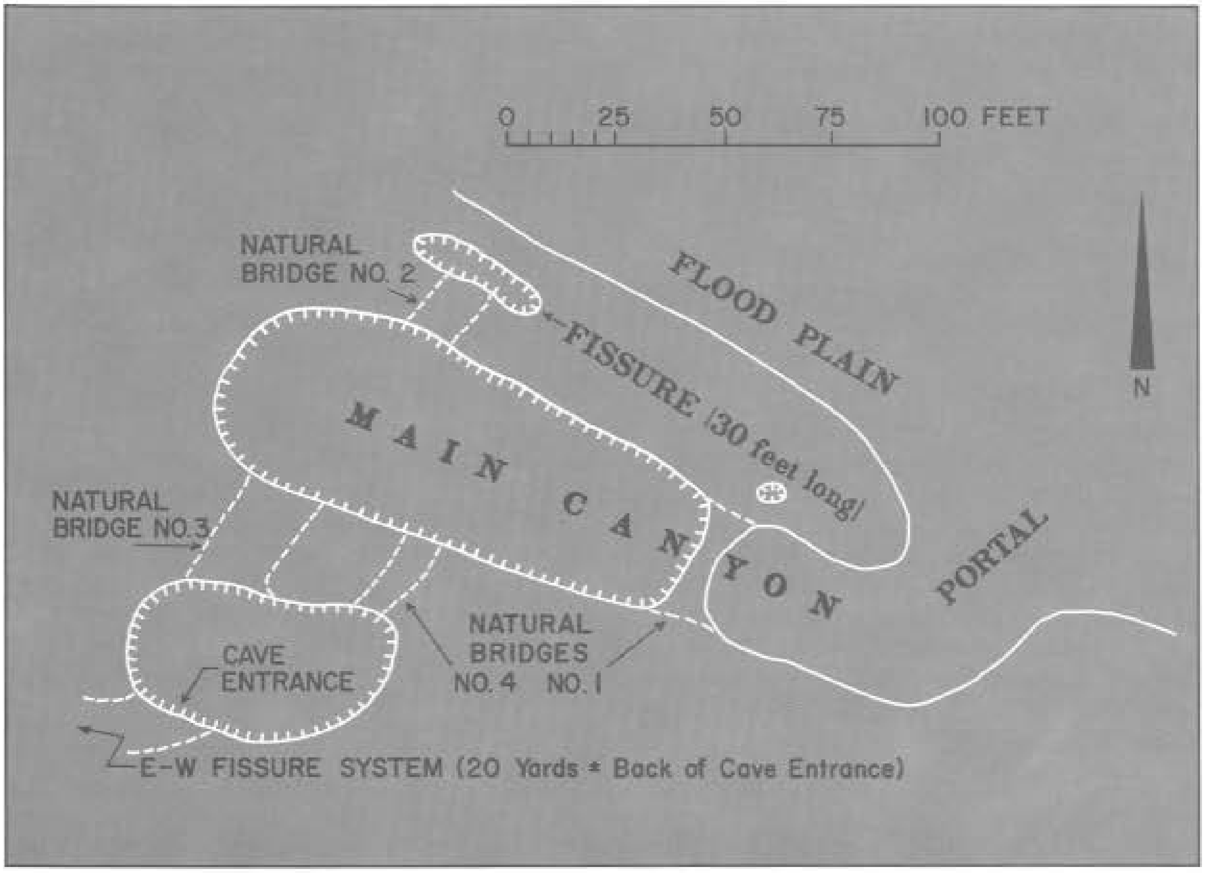

0 25 50 75 100 FEET
N
NATURAL BRIDGE NO. 2
FLOOD PLAIN
FISSURE (30 feet long)
MAIN CANYON
PORTAL
NATURAL BRIDGE NO. 3
CAVE ENTRANCE
NATURAL BRIDGES NO. 4 NO. 1
E-W FISSURE SYSTEM (20 Yards ± Back of Cave Entrance)

Figure 151

Kassel Cave Natural Bridges.

342. RATCLIFF CAVE SUNKEN GARDEN

Laclede County, 1 mile southeast of Phillipsburg, in SW¼ SW¼ SW¼ sec. 26, T. 33 N., R. 17 W., Phillipsburg 7½-minute Quadrangle.

The Sunken Garden is a cave system which has collapsed in part to produce an underground lake, natural tunnel and bridges, and a main atrium where the roof has been destroyed, leaving a depression 25 feet deep and 35 feet in diameter and encircled by sheer to overhung walls. Stone steps and walls constructed long ago for utilitarian purposes have acquired a patina compatible with the surroundings. Entrance is made down the stone steps at the east edge of the depression (fig. 152).

At the bottom of the steps the visitor may bear either hard right or hard left to large natural niches which have been walled to form a fruit cellar on the south side of the steps and an additional cellar on the north side. To the northeast of the steps across the Sunken Garden, a natural portal passes under a slot in the roof or natural arch and continues north and west to an underground lake approximately 25 feet in diameter. Artificial lighting is needed for viewing this lake (fig. 153).

The southwest part of the Sunken Garden has an exit through a natural tunnel leading out of the depression to the south and west with an additional anteroom to the east of the tunnel. This anteroom, in turn, is connected with the Garden by a natural tunnel which is now a slot

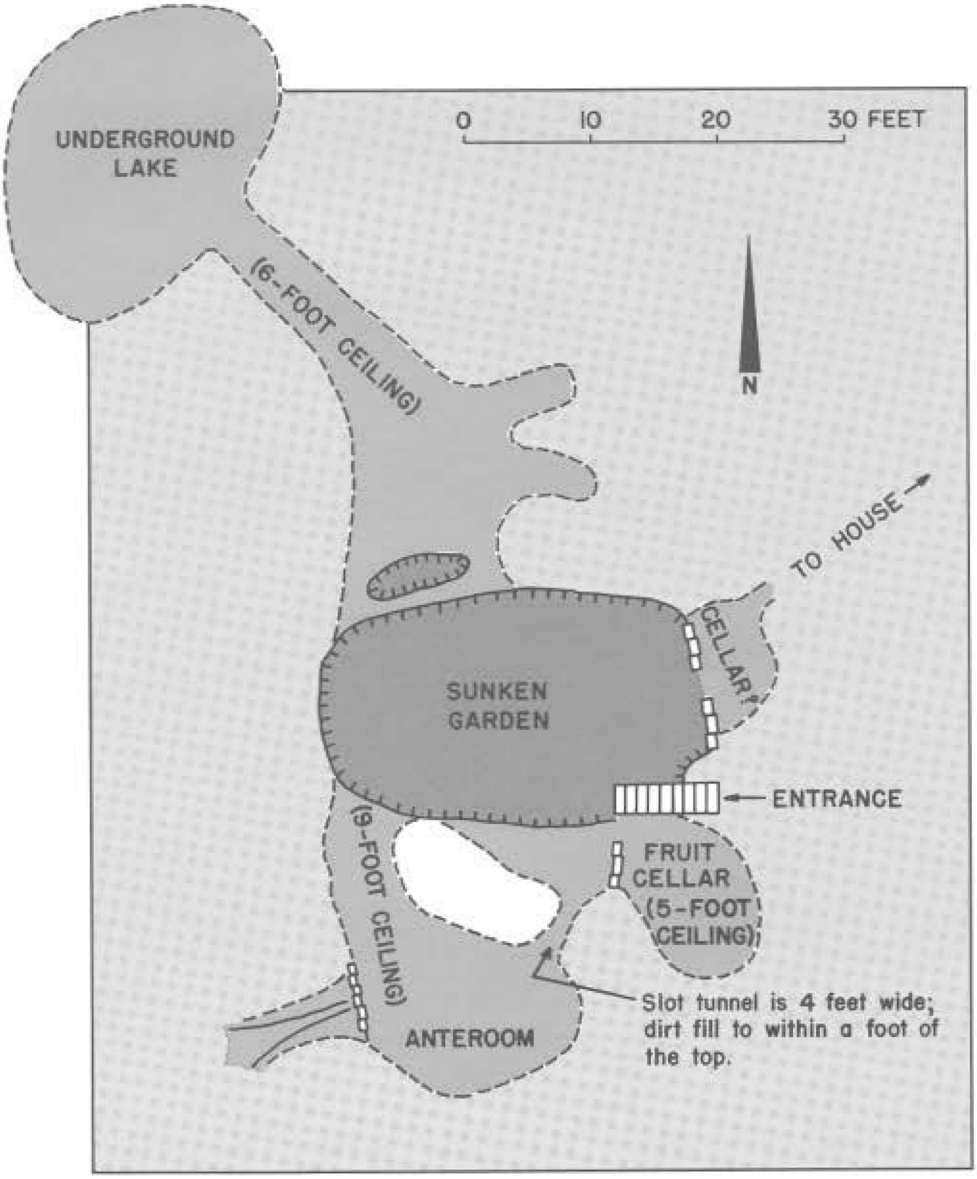

UNDERGROUND LAKE
0
10
20
30 FEET
(6-FOOT CEILING)
N
TO HOUSE
CELLAR?
SUNKEN GARDEN
ENTRANCE
(9-FOOT CEILING)
FRUIT CELLAR (5-FOOT CEILING)
Slot tunnel is 4 feet wide; dirt fill to within a foot of the top.
ANTEROOM

Figure 152

Ratcliff Cave Sunken Garden.

about 4 feet wide as a result of a natural dirt fill which comes within a foot of the top. Excavation of this fill would make the slot a natural tunnel which might be traversable on foot. Ferns flank the entrance steps and columbines would certainly flourish in the dark, moist environment of the Garden.

This site is southwestern Missouri's competition to southeastern Missouri's Kassel Cave (No. 341), both of them being prime examples of small-scale cave collapse with roof remnants forming natural tunnels and bridges. Because more of the roof of Kassel Cave has been destroyed, the natural tunnels and bridges are more easily photographed, but the lack of good daylight photography in the Sunken Garden is compensated by the charm of the atrium and underground lake. In addition, the large walled niches create an atmosphere of ancient ruins despite their relatively modern vintage. The site is a gem crying for some attention by a landscape architect or rock gardener!

Ratcliff Cave is developed in the lower part of the Jefferson City Dolomite. Fractures control

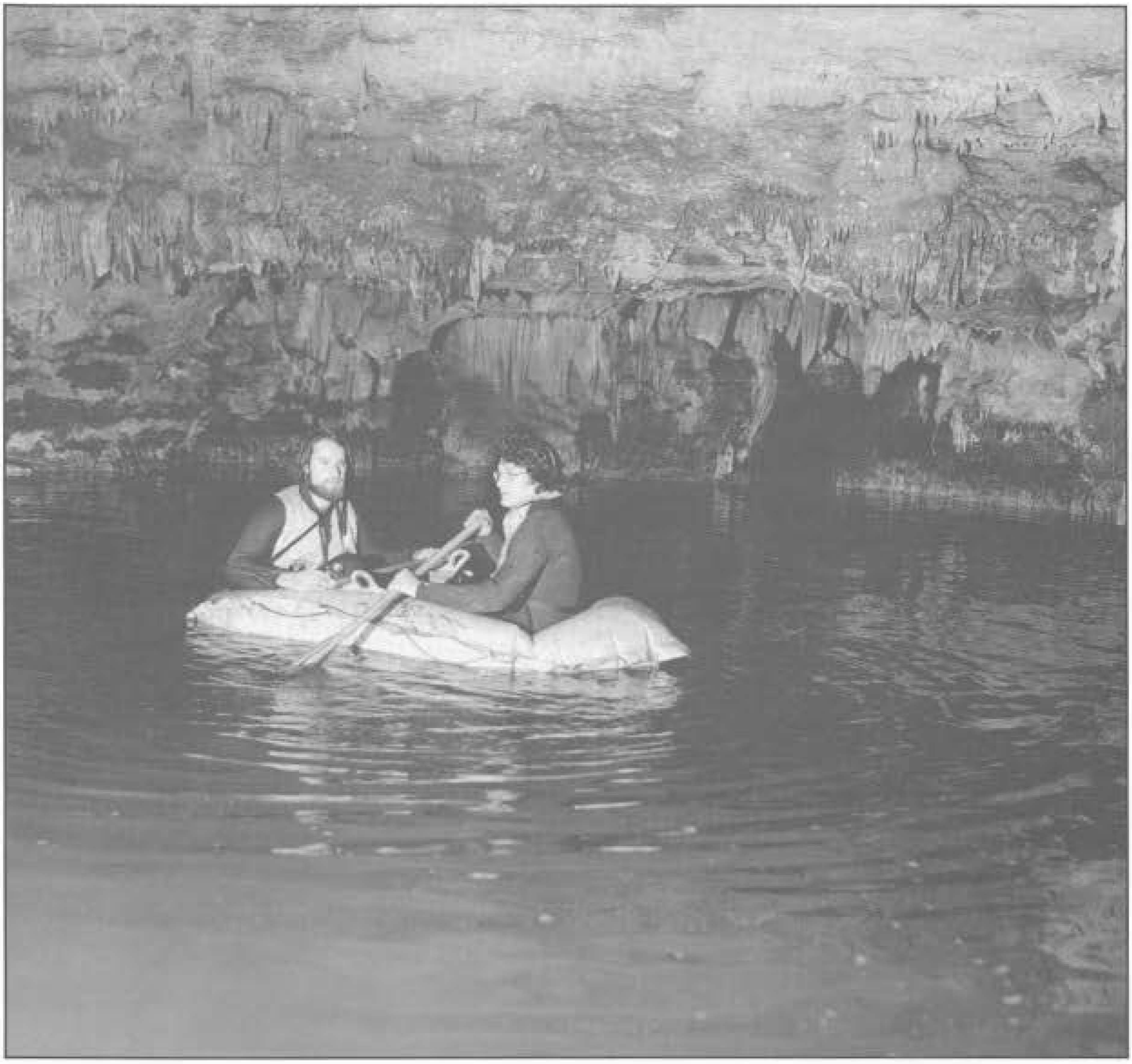


Figure 153

Ratcliff Cave Sunken Garden, this underground lake, a natural tunnel, and natural bridges were formed by the partial collapse of a cave system. Photo by Jerry D. Vineyard.

the trend of the voids with a conspicuous northerly grain and a secondary northwesterly elongation of passageways.

The site was reached by the following route (first obtain access permission):

Miles

0.0	*From Phillipsburg junction overpass on I-44, 11 miles southwest of Lebanon, follow Highway C southeast into Phillipsburg.*
0.45	*Turn right off "C."*
0.5	*Cross tracks and bear right and then left.*
0.95	*Straight ahead at T-junction.*
1.45	*Turn left (east) into lane.*
1.65	*Lane T-junction. Park and take lane to left (north). About 150 yards north of gate, take right-hand fork toward house. Sunken Garden is on left-hand side of lane, 40 yards southwest of house.*

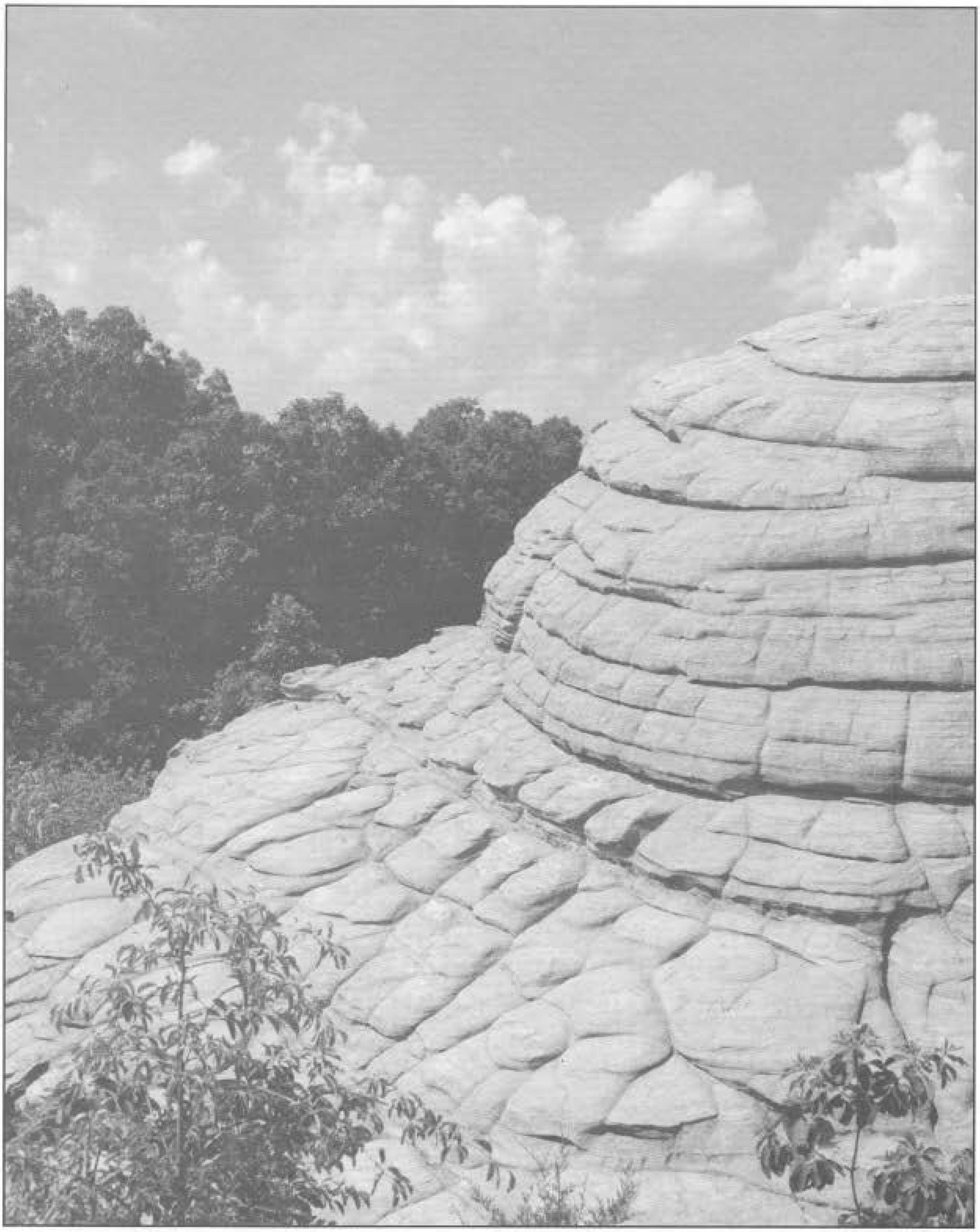


Figure 154

Missouri has a number of interesting large rocks. Photo by Jerry D. Vineyard.

11

Isolated Rock Prominences

Smaller than mounds and knobs, and different in origin from lost hills, isolated rock prominences are pinnacle rocks or barren masses of rock that are usually scenic landmarks. Their geologic histories vary according to the type of feature, its location, and geologic context.

343. CHIMNEY ROCK (HURRICANE CREEK)

Bollinger County, 1.5 miles east of Marble Hill, in west bluff of Hurricane Creek, in NW¼ NE¼ NW¼ sec. 33, T. 31 N., R. 10 E., Marble Hill 7½-minute Quadrangle.

Hurricane Creek Chimney Rock is not particularly large but is a good photographic subject, easily accessible, and close to Marble Hill. It is a column about 12 feet high on the upslope side and 25 feet high on the downslope or valley side. Its diameter is 3 to 4 feet in the upper part but varies depending on the resistance of the rock to erosion. The rock is Jefferson City dolomite which forms protruding ledges where thick bedded and re-entrants where thin bedded and weak. It is a remnant produced by weathering along vertical fractures parallel to and at right angles to the bluff line which is 25 feet back of the remnant. Chimney Rock is best photographed looking to the southeast.

The rock was reached by driving east on Missouri Highway 34 for 0.2 mile from the First Baptist Church, turning north (left) onto a gravel road 0.3 mile shy of the bridge where Highway 34 crosses Hurricane Creek. The gravel road was followed for 2.3 miles and the car was parked on the west side of an iron bridge. From this point, walk north along a pasture following the base of the bluff for approximately 0.5 mile to about 100 yards short of the section line fence. When foliage is at a minimum, Chimney Rock can be easily seen in the lower part of the bluff line to the left.

The Marble Hill area is also famous in geological circles as the only locality where dinosaur remains have been found in Missouri. See Stinchcomb (No. 200) for a description of these remains, discovered in a filled sink about 1 mile north of Glen Allen or about 3 miles northwest of Marble Hill.

Two miles northwest of the dinosaur remains site, or slightly over 2 miles northwest of Glen Allen, is a tunnel which was excavated for a now-abandoned portion of the Missouri Pacific Railroad. This tunnel, in sec. 22, T. 31 N., R. 9 E., is about 0.2 mile long, cutting through a rock spur on Crooked Creek as an alternative to a cut which would have been slightly over 100 feet in depth.

344. CHIMNEY ROCK (CEDAR CREEK)

Boone County, in northwest bluff of Cedar Creek, 4 miles east of Ashland, in SW¼ SE¼ SE¼ NW¼ sec. 16, T. 46 N., R. 11 W., Millersburg SW 7½-minute Quadrangle.

Boone County's Chimney Rock is exceptionally impressive with a maximum height of approximately 75 feet on the downslope side and an average diameter of some 20 feet. It is composed of Burlington Limestone which was sliced by vertical fractures at right angles to one another. Subsequent erosion of the fractured rock mass has left this isolated pinnacle as well as some nearby small jetties of rock protruding from the steep slope. Unfortunately, the rock is not easily photographed because of obscuring trees but should the site ever be developed, a judicious bit of timbering would enhance it. The dimensions cited are to be considered only approximate because the visit was made in early January when the top inch of the steep slope was thawed with resulting maximum lubrication and minimum climbing activity.

The inquiry regarding the name of the rock produced the answer "Chimley Rock" from a local senior citizen. Those who might question this pronunciation should recognize that it is Old English as it was used by Sir Walter Scott (Randolph and Wilson, 1953, p. 77) and has persisted in the speech habits of the southern Appalachians and Missourians.

The site may be reached either via Highway Y going east from Ashland or Highway J west of New Bloomfield. The Chimney Rock is faintly visible from Highway Y in the floodplain east of the bridge over Cedar Creek, looking to the north. It was reached by parking on the west side of the bridge and following the west bank of the creek northward for approximately 0.5 mile to the point where Cedar Creek makes a sharp, right-angle bend from northeast to southeast upstream. The rock is in the west bluff, very close to the elbow of this bend. The topographic map shows private roads and trails which could be checked for access from the north if the weather is sufficiently dry.

345. CHIMNEY ROCK (NIANGUA ARM)

Camden County, in Niangua Arm, Lake of the Ozarks, 5 miles northwest of Camdenton, in SW¼ SE¼ NE¼ NE¼ sec. 5, T. 38 N., R. 17 W., Green Bay Terrace 7½-minute Quadrangle.

The Lake of the Ozarks has made the Camdenton Chimney Rock almost a memory, but during low water approximately 6 feet of it protrudes above the surface. The exposed rock, reported to be about 15 feet long by 7 or 8 feet wide, was a well-known landmark before the lake was created. It must be reached by water and the location given above is somewhat approximate. The Chimney Rock Resort is on Lake Road 5-61, 6.3 miles north of the junction of Highways 54 and 5. To reach it, turn off Highway 5 to the west onto the Lake Road and follow it for 0.2 mile to the Chimney Rock Resort. The owner was most hospitable and cooperative in giving information regarding the dimensions of the rocks which are south of the resort. These rocks were near the now-flooded Arnholdt Cave (Weaver, 1975) which is approximately 1,000 feet south of Chimney Rock (Weaver, 1970, p. 47).

Weaver (1975, p. 1-14) has published a thorough research on Chimney Rock, as well as nearby Arnholdt and Onyx Caves, including a preinundation photo of Chimney Rock. He cites references referring to the Rock as:

"...a bold and majestic pinnacle of rock rising from the water's edge like a water tower and surmounted by a natural stone head and face, bearing a startling resemblance to an Indian chief in his bonnet."

He further states that:

"This head has been christened Ne-Ong-Way, which is also the ancient Indian name of the stream (Niangua), meaning under a liberal construction, 'Spring River'."

346. CHIMNEY ROCK (JACKS FORK)

Texas County, southeast bluff of Jacks Fork, 5 miles northwest of Mountain View, in SE¼ NE¼ SW¼ NW¼ sec. 28, T. 28 N., R. 7 W., Pine Crest 7½-minute Quadrangle.

This chimney is composed of Gasconade Dolomite which juts from the bluff to form a pinnacle nearly 100 feet high and 15 to 20 feet wide. At its base it merges with the bluff; at its crest it protrudes nearly 50 feet from the bluff line and is divided into twin spires. Its general appearance raises the question of how it escaped being called "The Devils Hitching Post."

The feature was viewed from the opposite bank of Jacks Fork and can be photographed from that side. Photography from the bluff side would accentuate the twin-pinnacled crest but sacrifice part of the background.

Chimney Rock is a product of parallel fracturing at right angles to the bluff with an isolated slender prism surviving erosion. A few yards to the northeast is another pinnacle capping the nose of the ridge and Chimney Rock Cave at a slightly lower elevation.

The visit, which was well worth the drive, was made by taking Highway Y north from Mountain View for approximately 6.5 miles. (Some might also be interested in seeing Missouri's largest dogwood tree, over 31 feet tall, in Nature Park several miles south of Mountain View.) A gravel road joins Y 0.15 mile south of the Jacks Fork crossing. This road was followed east and north for 1.4 miles, across Jacks Fork to a private lane shown on the Pine Crest Quadrangle on the right (east). Access was requested at the farmhouse on the left side of the lane which was then followed southeastward to a large cabin opposite Chimney Rock.

This lane may also be reached via Highway W southwest of Summersville. From its junction with Highway 17, 5 miles south of Summersville, W goes west for 3.75 miles to Arroll where it turns north. At Arroll, a gravel road is followed south for 2.4 miles to the lane entrance on the left.

347. CHIMNEY ROCKS AREA (PICKLE KNOB, RATTLESNAKE ROCKS, AND CHIMNEY ROCKS)

Ste. Genevieve County, 9 miles east of Farmington, in secs. 20, 22, and 27, T. 36 N., R. 7 E., Sprott and Coffman 7½-minute Quadrangles.

This area is especially photogenic because of its variety of sandstone erosion remnants. It is also a frustrating area because much of the land is very heavily posted against trespassing. The latter fact coupled with a shortage of time and a heavy rainstorm did not permit completion of study and photography of the varied and scattered geologic oddities.

Three general areas merit attention: Pickle Knob in SW¼ sec. 20 (section projected in part because of land grants superseding sectionalization); Rattlesnake Rocks in NE¼ NW¼ NW¼ sec. 27; and the main Chimney Rocks area in N½ NE¼ NE¼ sec. 27 and S½ SE¼ SE¼ sec. 22. All of these features are formed by erosion and weathering of the Lamotte Sandstone. Pickle Knob was not visited. It stands more than 150 feet above the ridge it surmounts and small knobs to the south of it suggest a chimney rock topography.

Rattlesnake Rocks was made for photographers and may be reached by the following route from Farmington:

Miles

0.0	*Turn right (southeast) off Highway 32 onto Highway AA, 5 miles northeast of Farmington.*
1.5	*Low pinnacles of Lamotte Sandstone to left at road junction. Continue on AA.*
3.0	*Junction with Hawn Park Road. Turn left (northeast) onto Hawn Park Road.*
4.7	*Park on low rise in road and walk to the south (right) for about 100 yards to west end of sandstone mass.*

On the north side near the west end of this mass (Rattlesnake Rocks) is a natural bridge with a 20-foot span, 9-foot ceiling, and 3-foot thick roof. The cavity is 25 feet long and is best photographed looking to the southwest. To the southwest of this bridge, on the west side of the main rock mass is a giant stone *Terrapin* ("tarpin" in Ozark dialect) with head on the full alert looking eastward. This chap is 14 feet long and 4 to 5 feet tall. He must be viewed looking southwest; from the opposite direction he loses his identity. A counter-clockwise trek around the west edge of the large rock mass is recommended to assure seeing the terrapin. After photographing the terrapin, bear left onto the main rock mass with camera on the ready for the *Balancing Rock,* a mass of sandstone 7 feet tall atop a 2-foot pedestal. This rock is most impressive shooting in a northerly direction. Continue a short distance eastward to encounter the *Devils Fretwork* (so-christened herein) on the north side of the large rock mass. Included in the fretwork is a small arch and smaller windows. An approaching storm precluded spending the time this area deserved. Plan to visit it when the foliage is light, wear appropriate shoes for climbing smooth rock surfaces, bring children of climbing age, and

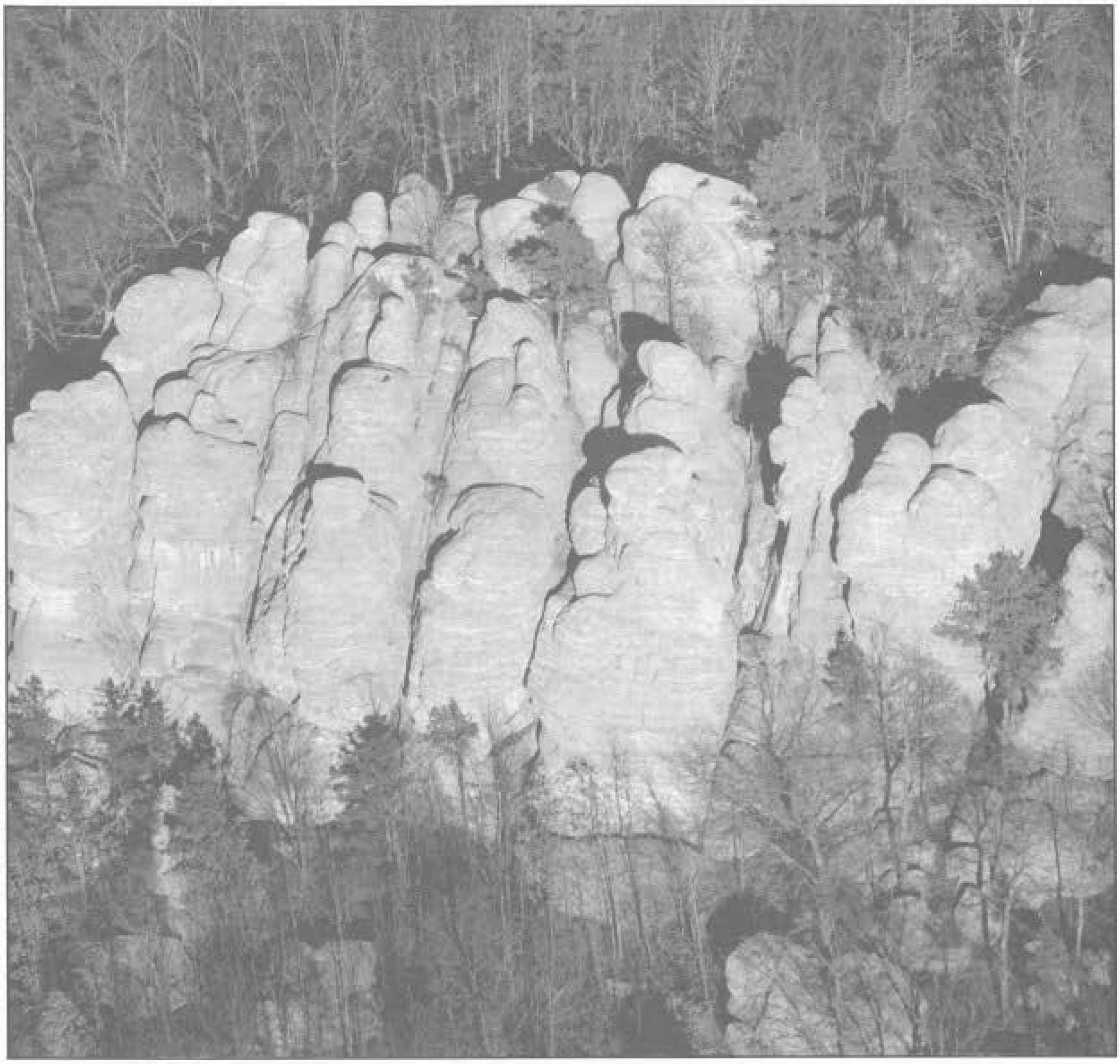


Figure 155

Chimney Rocks, near Farmington in Ste. Genevieve County, is one of the most impressive isolated rock masses in Missouri. Photo by David Hoffman.

have a plethora of film and time. A compass is very useful to maintain orientation while wandering among the mobiles on a cloudy day. No rattlesnakes were seen or heard during two spring visitations.

The Chimney Rocks area is farther east. An additional 0.2 mile eastward is a T-junction. A private lane to the right leads to the area which is east and south of the T-junction on heavily posted land. This is the most impressive representative of the Chimney Rock family in Missouri (fig. 155).

It is a large mass of Lamotte Sandstone crisscrossed by vertical fractures and subsequently weathered to produce a cluster of columns, some nearly 80 feet high, with knob-like crests. A smaller mass on the east side of the main cluster contains the *Devils Bake Oven* on its west flank. The Oven is an isolated arch capped by a chimney and reminiscent of a giant fireplace and chimney left as the sole survivors of a fire.

The Chimney Rocks and Bake Oven are not easily photographed from the ground because of trees. A small amount of tree and brush cutting would remedy this situation and make this site one of Missouri's top geologic wonders to the eye of the camera as well as the human.

Both Rattlesnake Rocks and the Chimney Rocks are the result of uneven weathering and erosion of the Lamotte Sandstone. Where individual sand grains are firmly cemented together, they resist weathering, as in the main mass of the Balancing Rock or the head of the Terrapin. The columnar structure of the Chimney Rocks probably results from vertical fracture planes intersecting and producing a covey of obelisks.

All the area described is most unusual, but a full day is required to do it justice and access permission should be obtained in advance.

The 1980 edition of the Coffman 7½-minute Quadrangle shows Chimney Rock about 0.75 mile east-southeast of the T-junction mentioned in the preceding paragraph. In addition, the map shows a prominent but heavily forested hill called Beehive Knob immediately east of the T-junction (NE¼ SE¼ SW¼ sec. 22).

348. BUZZARD ROCKS

St. Francois County, between Doe Run and Knob Lick, 5 miles south of Farmington, in SE¼ NW¼ sec. 26, T. 35 N., R. 5 E., Wachita Mountain 7½-minute Quadrangle.

By virtue of their general appearance, professional activities, and use as a figure of speech, buzzards are not particularly attractive to the eye, nose, or mind, but their namesake home in St. Francois County is attractive, well-maintained, and well worth the 0.75-mile hike needed to reach it. The most opportune hour for full sun photography would be prior to 11:00 a.m., because the southeast end is the most scenic. Winter or spring would be better than summer because of foliage problems.

.....looming up in the distance.....

The rocks are composed of silicified Lamotte Sandstone representing a segment of ridge along a major fault system extending southeast from the town of Doe Run, St. Francois County, to near Higdon in Madison County (McCracken, 1971, p. 22-26). This ridge is on the upstream side of the fault system and the north side of Buzzard Rocks is the surface of the fault plane.

Buzzard Rocks are 35 to 40 feet high and so attractively pinnacled as to deserve renaming them "Castle Rocks." They contain excellent examples of cross bedding; i.e., the sandstone strata are not all parallel to one another, but vary from being horizontal to inclined. This phenomenon results from shallow conditions in the seas at the time the sand was laid down. See figure 156.

From the Farmington area, Buzzard Rocks were reached by the following route:

Miles

0.0 *Junction Highways AA and H south of Farmington. Go south on AA.*

1.25 *Turn right (west) off AA onto black-topped secondary road (Cartee Road).*

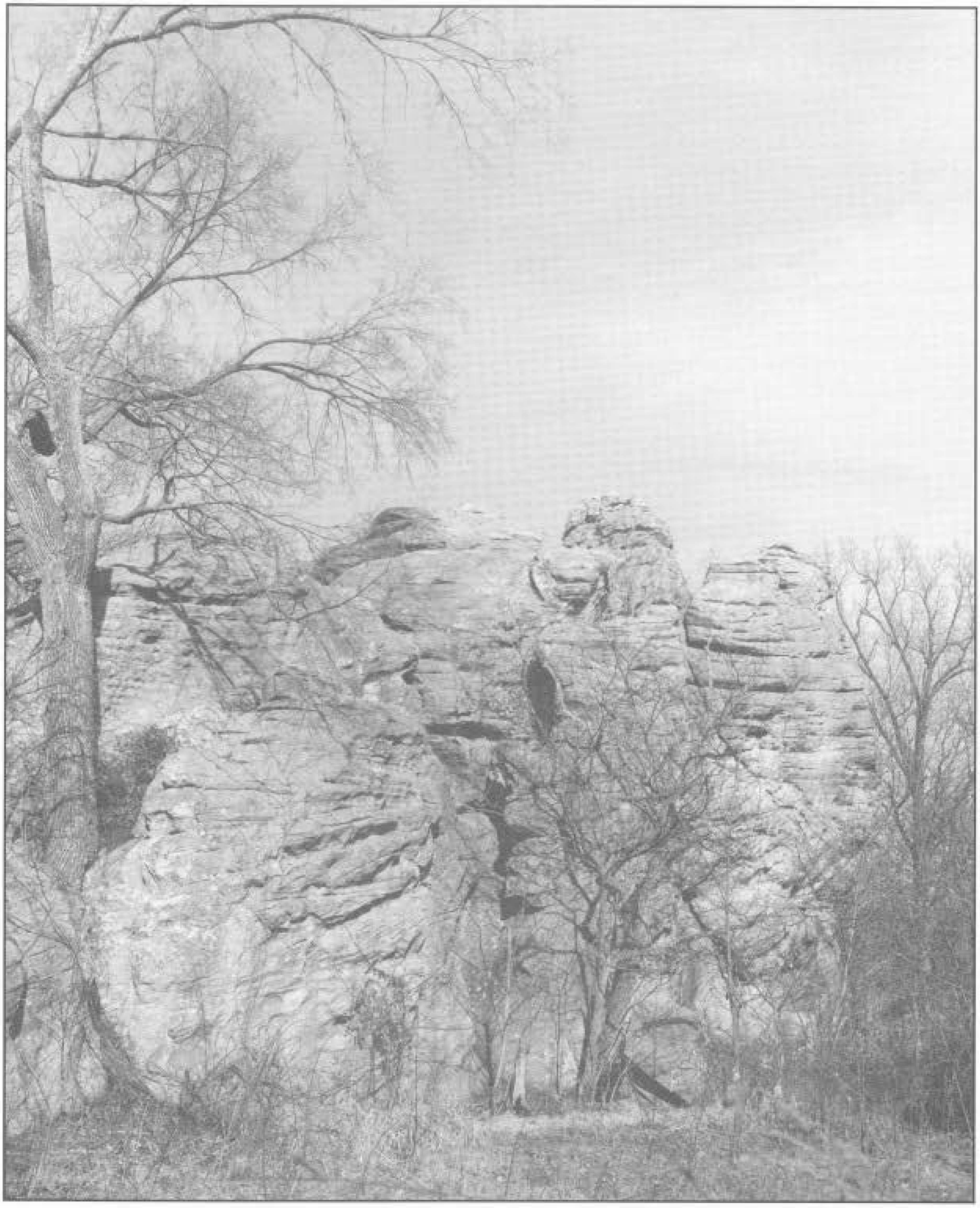


Figure 156

Buzzard Rocks in St. Francois County contain excellent examples of cross-bedded sandstone. Photo by Jerry D. Vineyard.

1.85 Community Center (shown as Cartee School on 1947 topographic map) on left. Turn right onto private land and obtain access permission. Follow trail northwest from brickhouse for three-quarters of a mile to abandoned house at terminus of powerline coming in from the south. This trail is the one shown on the 1947 topographic map. Buzzard Rocks are less than 100 yards northwest of the abandoned house and an impressive sight as they suddenly loom up from the rolling terrain.*

The rocks could also be reached by driving 0.15 mile farther west and following the powerline north by northwest from the blacktop to the abandoned house.

*Note: The directions were written for the 1947 edition of the Fredericktown 15-minute Quadrangle. The area is now covered by the Wachita Mountain 7½-minute sheet, but the older map may still be useful in navigating. The new map shows neither the trail nor the house, but the forest overprint edition shows a cleared area where Buzzard Rocks are.

349. CASTLE ROCK

Madison County, at S-F Scout Ranch, 3 miles southeast of Knob Lick, in northwest corner NE¼ sec. 24, T. 34 N., R. 6 E., named on Knob Lick 7½-minute Quadrangle.

Castle Rock is a Byzantine castellated erosional remnant knob of Lamotte Sandstone. Uneven erosion cooperated with vertical fractures to produce turrets and ports. The sandstone is cross-bedded, i.e., strata are not uniformly parallel to one another, suggesting a very shallow sea environment at the time the sand was deposited (fig. 157).

The mass is 50 feet high and ellipsoidal in birds-eye view with a maximum diameter of 160 feet and a width of 110 feet. It is a delight to both the climbing youngster and the more sedate viewer or photographer.

The entrance to the S-F Scout Ranch is on Highway 67 between Farmington and Fredericktown, or 2.8 miles south of the Highway DD junction at Knob Lick. From Highway 67, drive east into the camp and thence southeastward to Castle Rock. Hiking may be required and permission should be requested to visit the site. Follow the trail shown on the topographic map to the Rock, which lies east of Nims Lake.

350. DEVILS TEA TABLE

Clark County, 5 miles northeast of Revere, on bank of Des Moines River, in NE¼ NE¼ SE¼ SE¼ sec. 3, T. 66 N., R. 7 W., Croton 7½-minute Quadrangle.

The Devils Tea Table, on the south bank of the Des Moines River, is the most northeasterly extent of the Devil in Missouri on the basis of geological evidence, although theological evidence indicates that his realm extends over the whole state and a much broader area in addition. The Tea Table is a large, flat-topped slab of Salem limestone of Mississippian age. This brown stone has been the object of much attention over the years as shown by the many initials carved in it, some of which represent excellent craftsmanship dating back to the days when initial carving was an honored art.

The slab is an erosional remnant and may even have moved somewhat from its original position. It is 20 feet in maximum diameter and approximately 10 feet high. Those scouting for Devils Tea Tables in the Ozark area would expect to find them near the crest of major bluffs, so this one was a surprise, for rather than being on the bluff, it is at the water's edge. Reportedly a large slab of rock in the brush and slopes behind the Devils Tea Table likewise contains numerous initials and names which have been covered by moss and ivy. Had this Tea Table been in the Ozark area, it probably would not have been given the recognition it has, but the fact that such a type of outcrop is not as common along the Des Moines River has made the exposure locally unique.

The exposure was reached via the following route: From the cemetery at Revere, follow Highway DD north and east for 4 miles to its terminus at a T-junction. Bear right (east) at this T-junction on a gravel road and follow it for 1.05 miles to an abandoned house on the left. North-

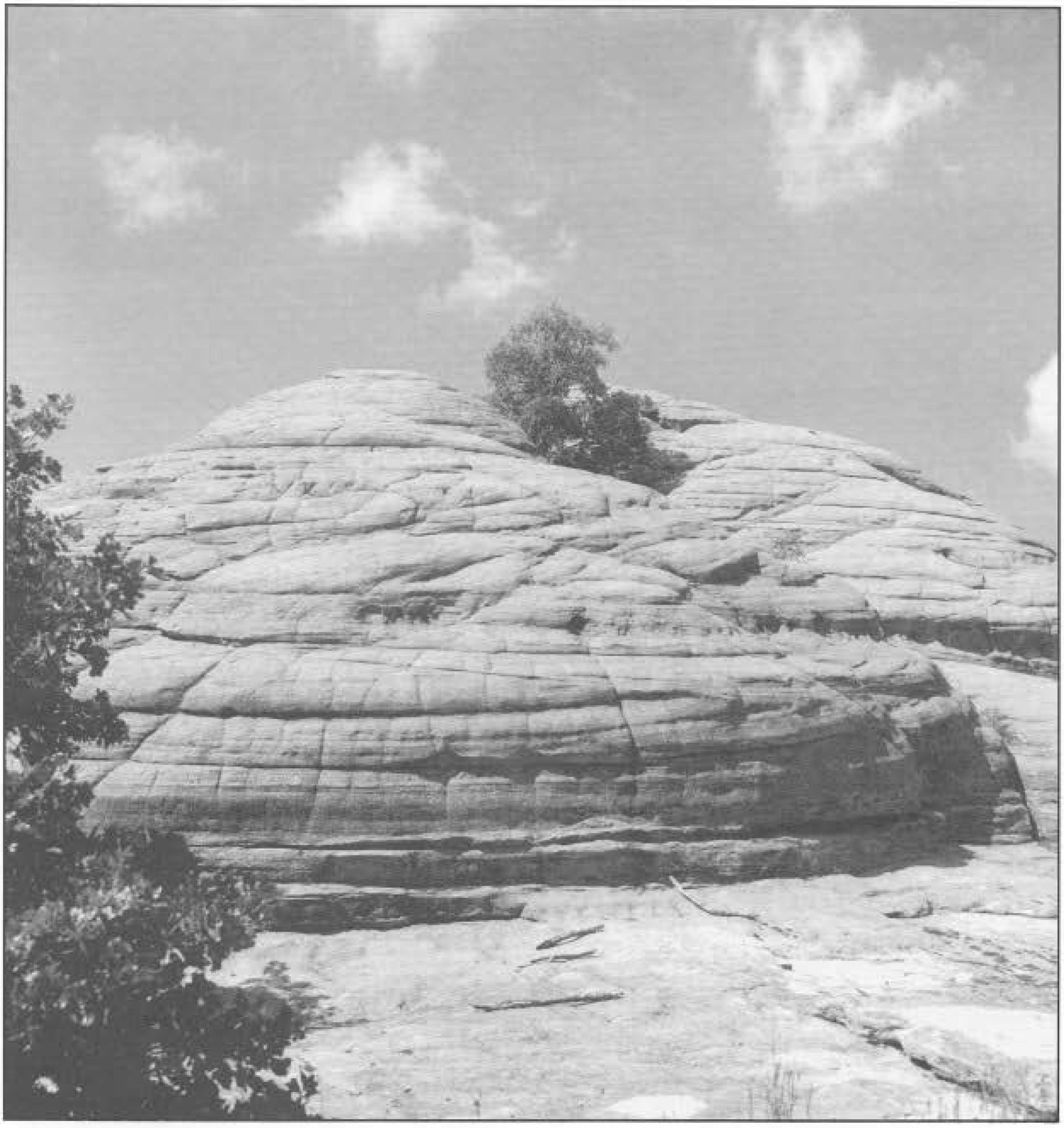


Figure 157

Castle Rock, a 50-foot high mass of Lamotte Sandstone, is at S-F Scout Ranch near Knob Lick in Madison County. Photo by Jerry D. Vineyard.

west of this abandoned house is a barn and a trail which trends slightly west of north. This trail is shown on the topographic map. Follow the trail which terminates at the section line between secs. 2 and 3. At the base of the bluff where the trail crosses a small ravine, keep a sharp eye out to the right for the Devils Tea Table. Should you wish a bit of sulfur water, stop at the spring on the west side of the trail which provides a permanent stream of water into the ravine that is crossed at the base of the bluff.

351. DEVILS TEA TABLES

Taney County, on west side of Beaver Creek, 6 miles east of Forsyth, in S½ S½ SW¼ sec. 11, T. 23 N., R. 19 W., Forsyth 7½-minute Quadrangle.

The Devils Tea Tables area consists of a pinnacled bluff crest containing a variety of natural sculpting including an excellent tea table or balancing rock, a spire which resembles a Scottish Terrier in one profile (fig. 158), and small caverns at the base of some of the pinnacling. The view from the pinnacled area is competitive with the view of the rock formations, for the 200-foot bluff overlooking the valley of Beaver Creek provides a vantage point for looking down to and through a perfectly clear stream and over a landscape which has changed little in the last hundred years.

Ideally, visit the area when foliage is at a minimum with the thought of working along the base of the bluff and watching for other interesting rock exposures as well as keeping an eye peeled to the upper part for the Devils furniture. The young and agile can climb up from the base. The area was visited in June when brush was relatively thick and it was more feasible to use a flanking rather than a frontal approach. From the junction of Highways 76 and 160, 3 miles east of Forsyth, the following route was taken:

Miles

0.0	*Turn southeast off Highway 76 onto 160.*
1.1	*Junction of Highways O and 160 at Kissee Mills. Continue on 160.*
2.75	*Turn left off 160.*
2.9	*Turn right on gravel road at T-junction.*
3.2	*Bear right at road fork onto rather rough and narrow road.*
4.6	*Park where road forks.*

From this point there is the option of walking the trail along the base of the bluff for an additional 0.5 mile and then climbing the bluff to the Tea Tables, or driving with the knowledge that there is an open area for a turnaround about a mile beyond the parking area. Those wishing to flank the Tea Tables and enjoy a gradual climb, should walk 75 feet north from the parking area along the base of the bluff until they encounter a convenient concrete step route to the crest of the ridge. On the local ridge crest a hand pump ahead of the stairway serves as an excellent navigational aid for spotting the steps and for turning on the final approach of the return

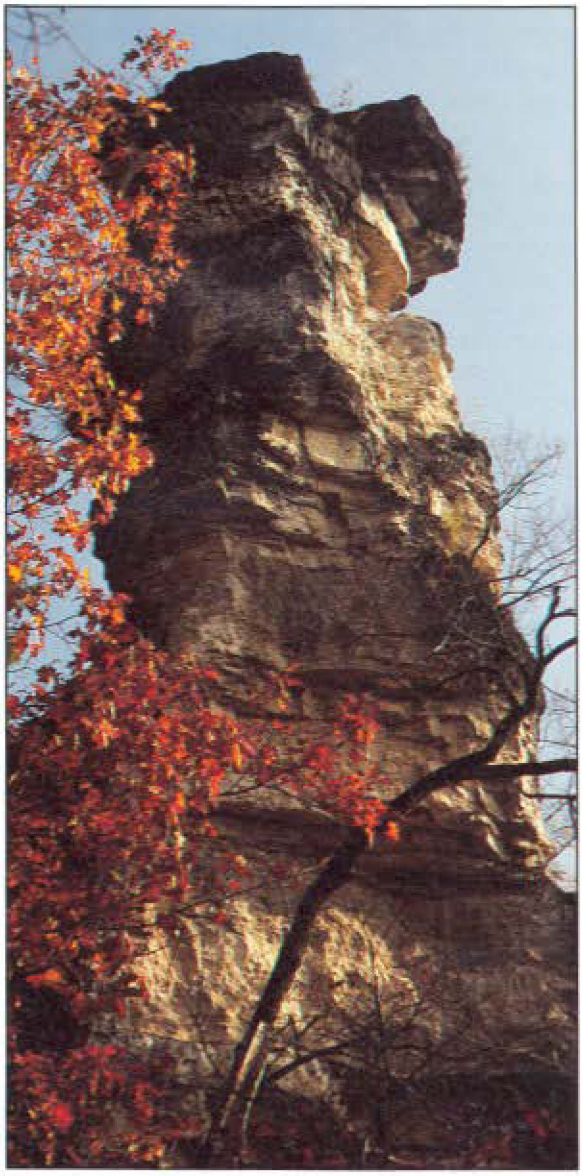


Figure 158

One of the Devils Tea Tables by Beaver Creek looks like a dog "sitting up for its master." Photo by Jerry D. Vineyard.

journey. From the pump area, bear right and stay near the edge of the bluff line, watching for the area of main pinnacling which is about 0.5 mile to the north.

Four promontories were observed, a lone one, and three that are closely spaced. The last two were the most spectacular with intense pinnacling and well-designed Tea Tables. More resistant rock formed the table top, while less resistant rock formed the pedestals. Vertical fractures set the stage for weathering which produced the pinnacles. Further scouting during the winter might reveal more such structures. The base of the outcrop should be given attention because solution activity has produced minute openings and fretwork in the rock (fig. 159). The structures were formed in differential weathering of Jefferson City dolomite.

The return from the pinnacles is easiest by angling toward the crest of the ridge and following a faint ridgetop trail back to the pump. While climbing to and following this trail, a considerable amount of well-rounded and polished stream gravel was noted indicating that at some time in the geologic past this ridge was part of a stream valley.

A topographic map is recommended for navigational aid on this visitation; also consider flood pool level because high water could necessitate additional walking. Those using the topographic map would be interested in noticing that the sections in the west half of this range are exceptionally narrow, being only 0.25 mile wide at the Tea Tables latitude. If you wish to own a section of land for bragging purposes, this is the area in which to buy it!

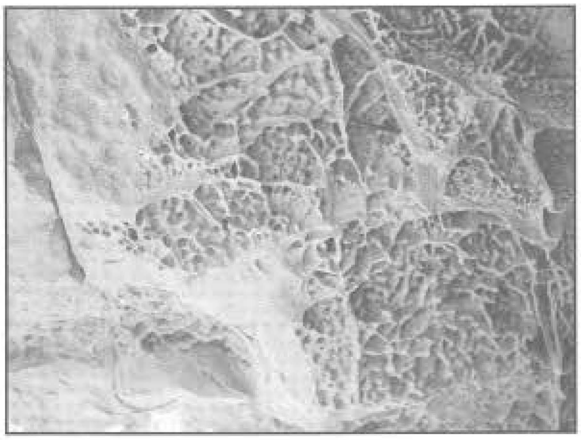


Figure 159

Solution activity has produced minute openings and fretwork under one of the Devils Tea Tables. Photo by Jerry D. Vineyard.

352. DEVILS DINING TABLE

Miller County, 2 miles west of St. Elizabeth, in east bluff of Osage River, in SE¼ NE¼ NE¼ SE¼ sec. 36, T. 41 N., R. 13 W., St. Elizabeth 7½-minute Quadrangle.

One of the most symmetrical and well designed pieces of the Devils furniture set is on the Ray Doerhoff farm — a most appropriate setting because Mr. Doerhoff is a practicing conservationist. The private road into his farm is a nature trail with signs marking and identifying the great variety of trees lining the road. This road serves as a most enjoyable teaching device for students from the St. Elizabeth School system of which Mr. Doerhoff is superintendent.

The Dining Table is composed of an elliptical slab of pitted Gasconade Dolomite, 3 feet thick and 15 feet in maximum diameter, centered on a pedestal of thinner bedded cherty dolomite, 4 to 8 feet in diameter and 15 feet high on the downslope side and 5 feet high on the upslope or bluff side. The top of the Table is at the same elevation as the top of the nearby bluff line, indicating that the thick pitted dolomite is resistant to erosion whereas the thinner bedded underlying dolomite and chert erode more rapidly as water and freeze-thaw activity enter bedding planes and crevices. This exposure demonstrates that the rate of weathering of the rock is not necessarily related to its hardness. Chert is much harder than dolomite, yet the thin bedded chert, because it is brittle, tends to fracture and contribute to the more rapid weathering of the pedestal, resulting in its being appreciably narrower than its cap.

The best time for photography would probably be in the afternoon and preferably when foliage is at a minimum. The Devil knows no seasons, but the proximity of St. Elizabeth assures a feeling of protection and complete safety.

Because the site is best reached by private lanes, the courtesy of requesting access permission should be observed. The following route is the simplest one:

Miles

0.0	*Drive west at junction of Highways 52 and E in St. Elizabeth.*
0.05	*Highway E turns right (north); continue straight ahead (west) on gravel road.*
1.75	*Turn right off gravel road through gate onto private lane with natural trail identifications.*
3.25	*At farmhouse; bear right through gate and follow base of bluff for an additional 0.4 mile to bluff on north side of first major ravine. Devils Dining Table is conspicuous along the bluff line a few yards north of the ravine.*

353. BLUFF PINNACLE

St. Charles County, in north bluff of Missouri River, 1.35 miles west of Daniel Boone Bridge (Highways 40 and 61), 2 miles south of Weldon Spring, in NW¼ SW¼ SE¼ NE¼ sec. 4, T. 45 N., R. 3 E., Weldon Spring 7½-minute Quadrangle.

This site was not visited, but is very conspicuous on an aerial photograph looking north into the bluff (fig. 160). The topographic map shows this isolated rock mass rising approximately 120 feet above the river floodplain. It probably would be most impressive as seen from the river or from a low-flying aircraft.

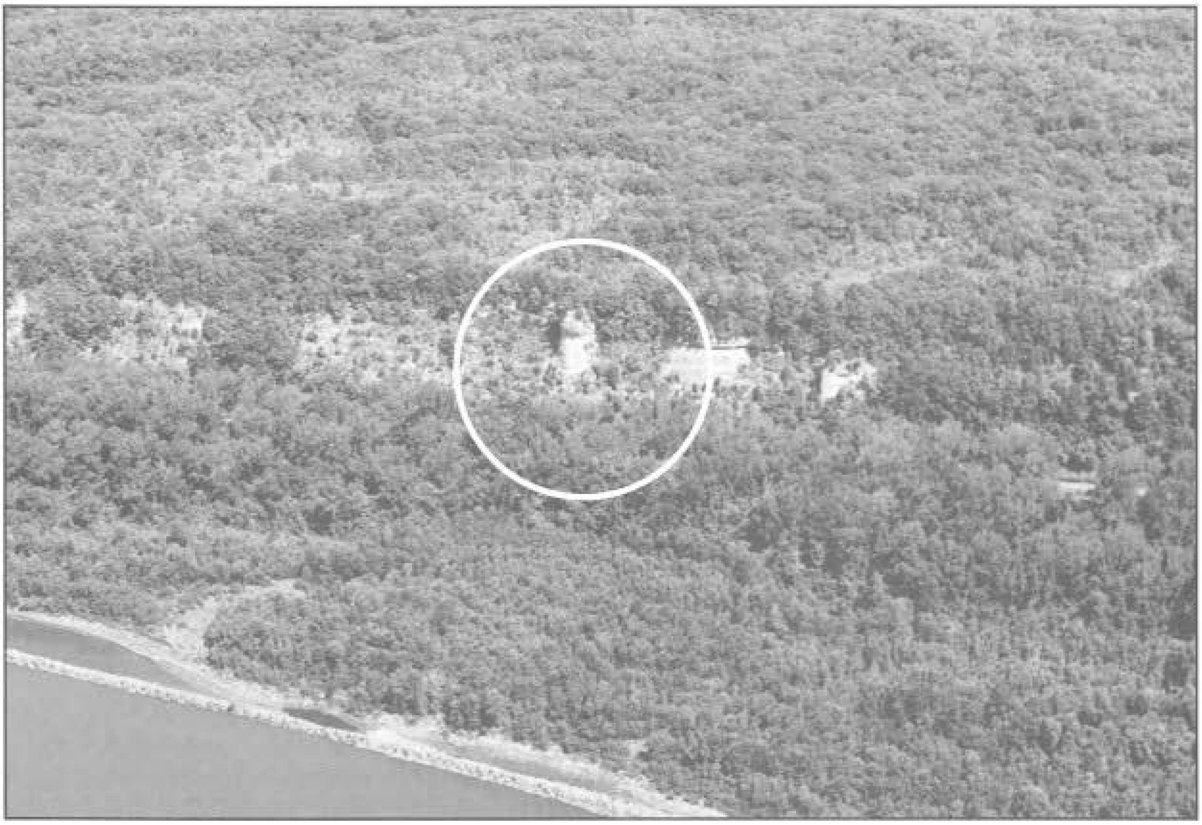


Figure 160

An isolated rock mass (No. 353) rises some 150 feet above the Missouri River floodplain in St. Charles County. Photo by David Rath.

354. COURTOIS PINNACLE (JDV)

Crawford County, 3.5 miles southeast of Onondaga Cave, in Huzzah State Wildlife Management Area, on the north side of Courtois Creek, in SE¼ NE¼ sec. 12, T. 38 N., R. 3 W., Onondaga Cave 7½-minute Quadrangle.

Courtois (pronounced Coat-away, in Ozark vernacular) is just one of several interesting features in a small part of the Missouri Department of Conservation's Huzzah Wildlife Area. There is a parking area in the NW¼ SE¼ sec. 12, and a trail leading northeast along the bluff. Follow the trail for a quarter mile, beneath a "leaning rock gateway" (a huge fallen slab of bluff rock leaning against the sheer rock face, forming a triangular opening through which the trail passes), past four small cave openings, to the pinnacle.

Courtois Pinnacle is 15 to 20 feet high, standing in the manner of a lone sentinel guarding the entrance to a small cave with an entrance about 20 feet wide and 8 feet high, about halfway up the hillside, overlooking a right-angle bend in Courtois Creek. One imagines an earlier time, when Indian hunters might have taken shelter in the cave. Both the cave and the pinnacle are weathering phenomena, features common in the thick-bedded Ordovician dolomite bedrock of the Ozarks.

Between the pinnacle and the bluff trail is the mouth of a small, rock-walled hollow that has cascades during rainy weather. The hollow is much like what would be called a "box canyon" in the West.

Courtois Pinnacle alone is not worth driving far to see, but there are numerous other things to see. There are spectacular bluffs along Courtois Creek, especially the one on the south side of the creek across from the parking area. The large entrances to Bat Cave and Bear Cave attract attention, but one must either have a boat or be prepared to wade. One mile south is the Narrows (page 116), and the site of the old Scotia iron furnace lies about 1 mile east of the pinnacle.

355. SMITH CREEK PINNACLES

Callaway County, 4 miles west of Carrington, at junction of Smith Creek and Cedar Creek, in NW¼ sec. 35, T. 47 N., R. 11 W., Millersburg SW 7½-minute Quadrangle.

These pinnacles are reported to be limestone; no other data are available.

356. BONNE FEMME CREEK PINNACLE (JDV)

Boone County, 6 miles west of Ashland, on common east bluff line of Missouri River and Bonne Femme Creek, in SW¼ SE¼ SE¼ NW¼ sec. 15, T. 46 N., R. 13 W., Jamestown 7½-minute Quadrangle.

This pinnacle is visible on aerial photographs and is approximately 60 feet high. Reportedly visible from road when vegetation is not in leaf.

357. CHIMNEY ROCK (JEFFERSON COUNTY)

Jefferson County, near north end of Kimmswick, 0.75 mile north of the mouth of Rock Creek, in east-facing bluff along railroad right-of-way (area not sectionalized), Valmeyer 7½-minute Quadrangle.

A Board of Examination Chart (1908) identifies this feature on a promontory of a 120-foot bluff. The site was not visited.

358. STANDING ROCK NO. 1
359. STANDING ROCK NO. 2

Dallas County, on Niangua River, upstream from Bennett Spring Branch, Windyville 7½-minute Quadrangle.

George Kastler, former Ranger/Naturalist at Bennett Spring State Park, kindly furnished information on the Standing Rock sites on the Niangua.

He reports one (No. 358) as being a pillar about 30 feet high and 15 feet in diameter in SE¼ SE¼ NW¼ sec. 36, T. 35 N., R. 18 W., in the south bluff of the Niangua, 0.6 mile above the Bennett Spring Branch mouth.

The other (No. 359) reportedly borders Standing Rock Eddy in sec. 10 (probably in the NE¼), in T. 34 N., R. 18 W., about 4 miles southwest of Bennett Spring. No other data are available. The Windyville Quadrangle shows a Lone Rock Church west of Windyville. Might not there be a visit-deserving, lonely rock remaining to the west of the two Standing Rocks?

360. CAPE ROCK

Cape Girardeau County, at Cape Rock Park, northeast part of Cape Girardeau, in Mississippi River bluff, in center N½ SE¼ sec. 28, T. 31 N., R. 14 E., McClure 7½-minute Quadrangle.

According to Van Ravenswaay (1941, p. 200) *"...About 1720, a French ensign named Girardot (or Girardo), stationed at Kaskaskia as early as 1704, is thought to have settled on the Cape, a rocky promontory north of the present city on Cape Drive Parkway. Maps as early as 1756 designate this point on the river as 'Cape Girardot' or 'Girardeau'."* Van Ravenswaay further states (p. 205) that Ensign Girardot established a trading post in the vicinity in about 1733.

Cape Rock consists of Girardeau Limestone overlain by 27 feet of Sexton Creek Limestone, which is capped by the windblow silt-clay loess.

361. ANVIL ROCK (JDV)

Hickory County, 5 miles southwest of Fristoe, in SE¼ NW¼ SW¼ NW¼ NE¼ sec. 15, T. 38 N., R. 22 W., Fristoe 7½-minute Quadrangle.

Mastodon hunter Albrecht Koch excavated a bone-laden spring bog near Fristoe, Missouri in the mid-1800's, from which he removed scores of mastodon bones as well as those of several other animals. Long on showmanship and short on anatomical knowledge, Koch assembled whatever bones looked good to build an impressive creature with which he astounded many audiences.

In time Koch's creature came into the hands of the British Museum, where master paleontologists disjointed it, deleted the extraneous bones, and reassembled the finest specimen of the Ice Age mastodon, *Mammut americanum,* that has ever been found. It is still on display in the British Museum.

The spring bog enjoyed local fame for some time, and several other would-be showmen hunted creatures in the Koch spring, but he had already recovered the best bones. In due time it was forgotten, and save for the chance mention of Anvil Rock in Koch's published report, it and Anvil Rock might still be lost.

According to Koch, his spring bog was 200 paces away from Anvil Rock, from which promontory the spring could be seen, but more than a century later no one remembered either the spring or the rock. The area would be flooded by the waters of Truman Lake, an impoundment under construction by the Corps of Engineers. Archaeologists, working to salvage what they could in the few years remaining before completion of Truman Dam, began to look for the Koch site. They found and excavated several spring bogs, but none that fitted Koch's description. Finally R. Bruce McMillan (personal communication) found an old farmer who remembered Anvil Rock, and there, 200 paces away, was the forgotten spring. Subsequent excavation revealed Koch's original digging platform, preserved in the miry depths of the spring.

Anvil Rock is aptly named and sized for a titanic smith. It is about 12 feet long and 5 feet wide, jutting from a dolomite "workbench" that rises 20 feet above the wooded hillside. The best way to find Anvil Rock is to find Koch Spring first, because it lies in a grove of trees on the floodplain of the Pomme de Terre River, on the edge of a field. Then strike out southwesterly for "200 paces" to Anvil Rock, on the upper slope of a densely wooded hillside (fig. 161).

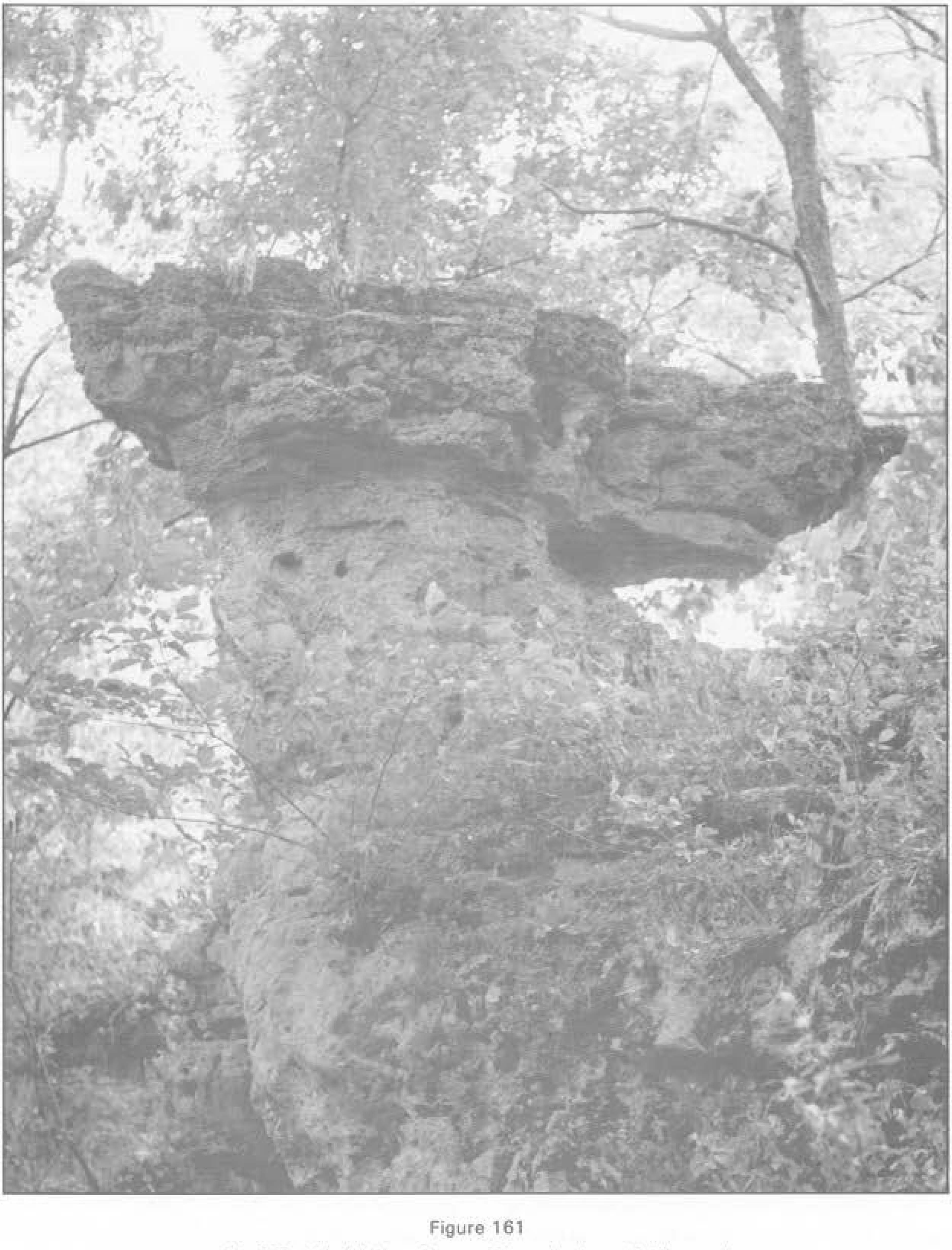


Figure 161

Anvil Rock in Hickory County. Photo by Jerry D. Vineyard.

362. LONE ROCK

St. Clair County, 5 miles south by southwest of Roscoe, in NE¼ NW¼ SE¼ sec. 7, T. 36 N., R. 26 W., Roscoe 7½-minute Quadrangle.

Musser (1975) describes this as *"...a large sandstone outcrop 30 feet high and 180 feet in circumference. The stone is highly eroded with several large boulders."* The site has sufficient identity to be named on the quadrangle map. The sandstone is probably Pennsylvanian in age.

The site is less than a mile north of Highway 54 on the west side of a private lane, 0.25 mile off Highway K.

363. THE CANDLESTICKS (JDV)

St. Francois County, 5 miles northeast of Lake Killarney, along west side of Wachita Creek, in sec. 16, T. 34 N., R. 5 E., Wachita Mountain 7½-minute Quadrangle.

The Candlesticks are a series of sandstone pinnacles so impressive and so unusual that it is amazing that no geologist had ever reported them. There were no references to them in literature; they were not shown on any maps known to the Geological Survey. Mr. Walter Solovik (personal communication, 1982) called them to our attention and graciously guided me to the site, which is privately owned.

Most of the pinnacles in Missouri are phenomena of limestone terranes, but The Candlesticks are spires eroded in the Lamotte Sandstone, the sedimentary rock formation that usually rests on the igneous "basement" rocks of Missouri, which reach the surface only in the St. Francois Mountains area. The Lamotte is a very old formation, composed of sand derived from the erosion of the ancestral St. Francois Mountains. The bulk of the volcanic and intrusive igneous terrane, which once must have been spectacular, was eroded away and deposited as sand and finer sediments in the ancient seas that surrounded the St. Francois Mountains area; the higher peaks thus became as islands. The sandy beaches, over time, became the Lamotte Sandstone, and the muds and lime oozes that accumulated farther offshore became the shales and dolomites we know today.

Because of its origin in an ancient near-shore environment, the Lamotte Sandstone has layering and cross-bedding characteristics of beach sands. These features can be seen today in the sides of The Candlesticks. Close inspection shows sand grains of quartz and other minerals from breakdown of igneous rocks. The grains were arranged and sorted in layers by wave action, in the same way the surf arranges and rearranges beach sands today, then frozen in time as a rock formation.

The Candlesticks themselves are not old, only the rock from which they were eroded. They are the product of the current erosion cycle, by-products of the valley-cutting of Wachita Creek, which left these pinnacles aberrant remnants of the former landscape.

Six pinnacles form the group collectively called The Candlesticks. The centerpiece is a rock bluff crowned by three towering pedestal rocks called the Candelabra (fig. 162). These are about 20 feet high, but they appear much higher from a vantage point along the Wachita Creek. The tops of the three towers are flared, looking amazingly like a huge candelabra. The structure of the ancient sandstone is clearly shown; mosses and lichens add gray and green to the rust-colored sandstone, and weathered pockets add a pleasing texture to the rock.

Just north of the Candelabra is a single rock pinnacle called the Lone Sentinel (fig. 163). It is smaller than either of the three pedestals of the Candelabra, but the sides are beautifully sculpted by weathering and the top is covered by a lush growth of small ferns.

Across a small side hollow and a few hundred feet north of the Lone Sentinel stands The Guardian (fig. 164), an oddly shaped pedestal rock about 15 feet high. A bit farther north is The Toadstool (fig. 165), which has a narrow stem and a large, loose boulder on its cap. Still farther north, along the side of the valley, is a rock outcrop where the sandstone, deeply pitted by weathering, forms "Honeycomb Rock." The outcrop is not large, but a short walk and sharp eyes will be rewarded.

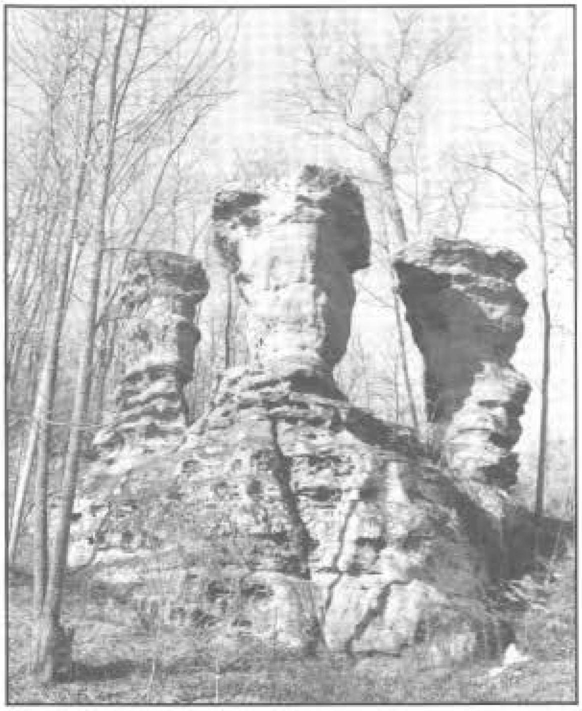


Figure 162

The aptly named "Candelabra" is a three-spired rock formation that taxes the geologic imagination to explain why there are three rather than one, or four. The pink color is typical of the Lamotte Sandstone, which is derived from weathering and erosion of the ancestral St. Francois Mountains. Photo by Jerry D. Vineyard.

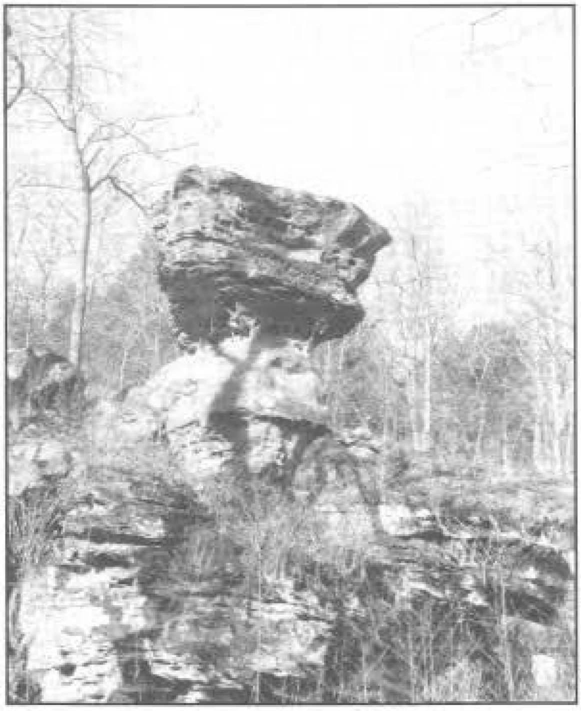


Figure 163

The "Lone Sentinel" is so-named because it stands in a strategic position as one approaches The Candelabra. The shape of the erosion-sculpted pinnacle results from the relative resistance to erosion in the sandstone beds of the Lamotte formation. Photo by Jerry D. Vineyard.

364. PICKLE SPRINGS SANDSTONE COMPLEX (JDV)

Ste. Genevieve County, 4 miles west-southwest of Hawn State Park, off Highway AA, in N½ NE¼ sec. 30, T. 36 N., R. 7 E., Sprott 7½-minute Quadrangle.

Pickle Springs sandstone complex is an area of rugged, forested hills that have several barren rock exposures of sandstone, and box canyons with waterfalls. It is here called a sandstone complex because there are so many interesting and diverse features to see, including arches, sandstone caves, "hoodoos," bluffs, box canyons, and a spring.

The area is owned by the Missouri Department of Conservation, which has named the 180-acre tract Pickle Springs Natural Area, after an early settler named William Pickles. According to legend, Mr. Pickles was shot by the notorious outlaw Sam Hildebrand and his band of renegades sometime during the Civil War.

For the convenience of visitors, the Conservation Department has built a nature trail through the area and provides illustrated trail guides.

Following the trail guide, the visitor walks through "The Slot" to reach the area called "Cauliflower Rocks," where one can see several natural arches and a massive boulder called "Terrapin Rock."

Double Window Arch is a special type of buttress arch, in this case holding up a rock shelf jutting out from a sandstone mass like the prow of a ship. There are two openings or

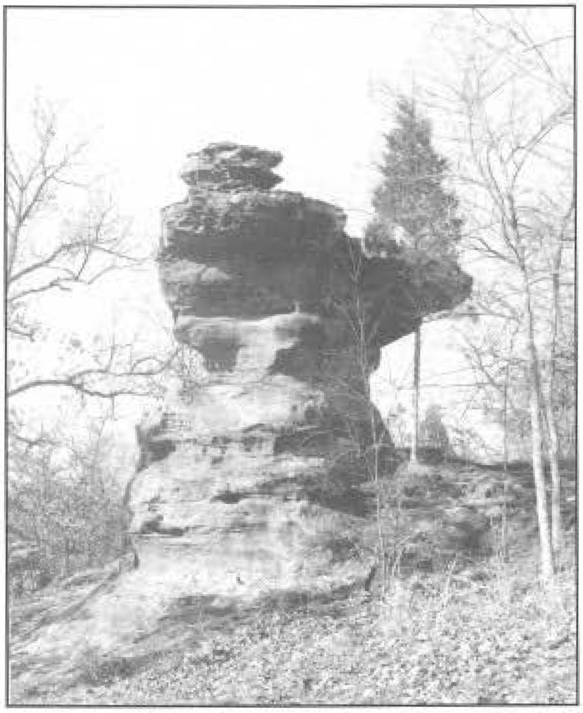


Figure 164

"The Guardian" performs the same function as the "Lone Sentinel," but in a different location. Photo by Jerry D. Vineyard.

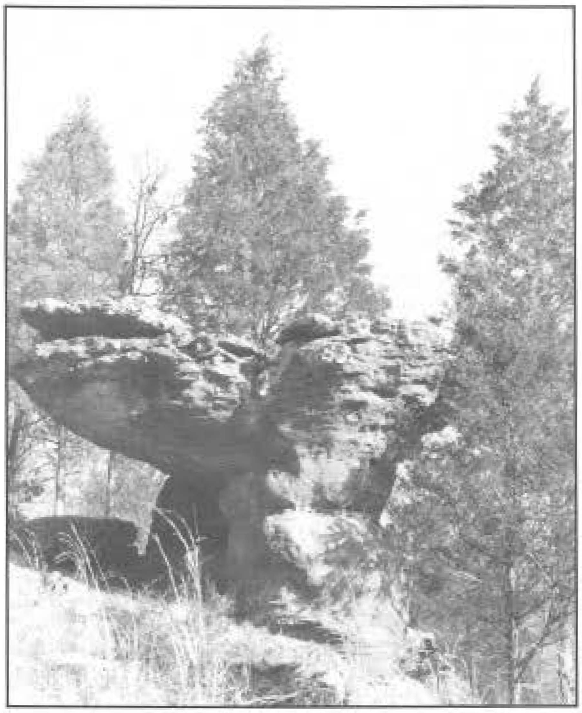


Figure 165

"The Toadstool" differs from the other Candlesticks by having a wide, flat top that evokes the appearance of a mushroom (toadstool). Its origin and geology is the same as the other pinnacles nearby. Photo by Jerry D. Vineyard.

"windows," side-by-side, separated by thin rock columns. Each opening is high and wide enough for a person to walk through. The shelf over the window arch supports three huge rocks, two of which actually form still another small arch.

Nearby is Leaning Rocks Arch ("The Keyhole"), formed by two huge rock masses leaning against each other. Scattered around the area are other large sandstone masses; some are bedrock outcrops, others just loose boulders. Scattered pines and oaks wrest a living from the thin soil, forcing their roots down into fractures of the rock to get a windproof grip.

The nature trail continues, down and across Pickle Creek to High Crossing, Twin Bridges, Spirit Canyon, and Owls Den Bluff to Dome Rock (fig. 166), an eroded sandstone knob that resembles Chimney Rocks near Fredericktown. Here the Lamotte Sandstone is transected by joint systems that direct erosive processes resulting in the development of hoodoos, spines, pinnacles, or "chimneys," and a castellated appearance. The Dome Rock complex has a major joint (or small fault) that is nearly vertical and oriented roughly north-northeast-south-southwest. This feature forms an obvious plane across the outcrop, along which erosion has cut a trench-like feature.

Perhaps the most unusual features in the Dome are the cave and natural tunnel near the base of the sandstone outcrop. One can easily walk through the tunnel, which is about 55 feet long. In appearance, it resembles a solution cave; in fact, intergranular solution of cementing material probably was a major factor in the development of this feature.

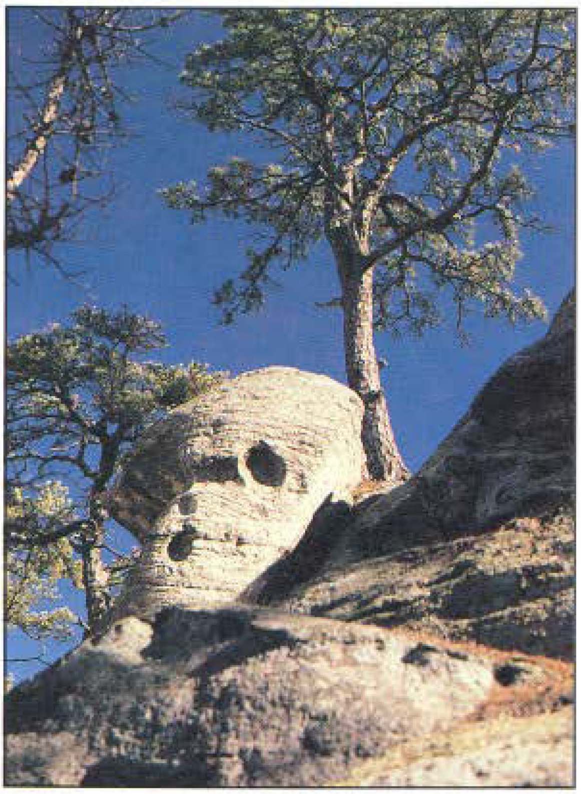


Figure 166

From one spot along the Pickle Springs Trail, when the sun angle is just so, a large sandstone rock formation takes on the appearance of a skull. Photo by Jerry D. Vineyard.

The sandstone cave, called Hoodoo Cave, is south of and at a lower elevation than the tunnel. It is smaller, but longer; basically, the cave is a multi-entrance, low-ceilinged passage that seems to have developed through solution-erosion along joint and bedding planes in the Lamotte Sandstone.

The nature trail continues past Pickle Spring and its miniature "Reflection Falls," to Rockpile Canyon and Headward Falls. The great rockfall that left a jumbled pile of massive boulders also produced a sheer sandstone bluff along the south side of the canyon. From a vantage point atop the rockpile, one can see at least six small sandstone arches along the south wall. One is a cave-arch at the base of a hoodoo; three others are stacked one atop the other, and together they form an "arch village."

The entire area is cut by prominent joints; many of the features develop along them. A prominent northwest-southeast joint splits the south bluff line, along which an incipient joint-cave has developed.

At the head of Rockpile Canyon there is an intermittent waterfall, perhaps 25 feet high, that develops impressive ice falls in winter, while in summer its cool shaded recesses harbor ferns and mosses.

365. THOX ROCK (JDV)

Phelps County, 6 miles north of Doolittle, in Gasconade River, in NE¼ SE¼ SW¼ sec. 5, T. 38 N., R. 9 W., Nagogami Lodge 7½-minute Quadrangle, on which it is named.

Thox Rock is in the middle of the Gasconade River, the middle of which also marks the boundary between Phelps and Maries Counties. To give the rock the benefit of the doubt, we place it in Phelps County, where the resort of the same name is located.

History does not record when Thox Rock broke away from the high bluff along the north bank of the river and slid or tumbled downslope into the Gasconade, but it was geologically very recent. What a splash it must have made!

366. TWIN ROCKS (JDV)

Maries County, 0.75 mile south of the village of Gascondy, on the east bank of the Gasconade River, in SE¼ NE¼ NW¼ sec. 19, T. 41 N., R. 8 W., Summerfield 7½-minute Quadrangle.

These midstream rocks are typical of many along Ozark rivers, which are characterized by sinuous, deeply entrenched meanders with bluffs on the outside bends, and slip-off slopes on the inside bends (see discussion of Ozark stream sinuousity and entrenchment beginning on page 109). Only rarely is there an opportunity to witness an actual rockfall, such as that described on pages 89-91, because these events are so few when viewed on a human time scale, yet so frequent on a geologic time scale.

12

Glacial Erratics

Thanks to glaciation, northern Missouri not only has some excellent soil, but also a smorgasbord of rocks imported from northern United States and Canada. Large glacially transported boulders are called erratics, and igneous or metamorphic erratics in northern Missouri had to travel a minimum of 300 miles, a major transportation challenge for those the size of Nos. 367, 370, and 371!

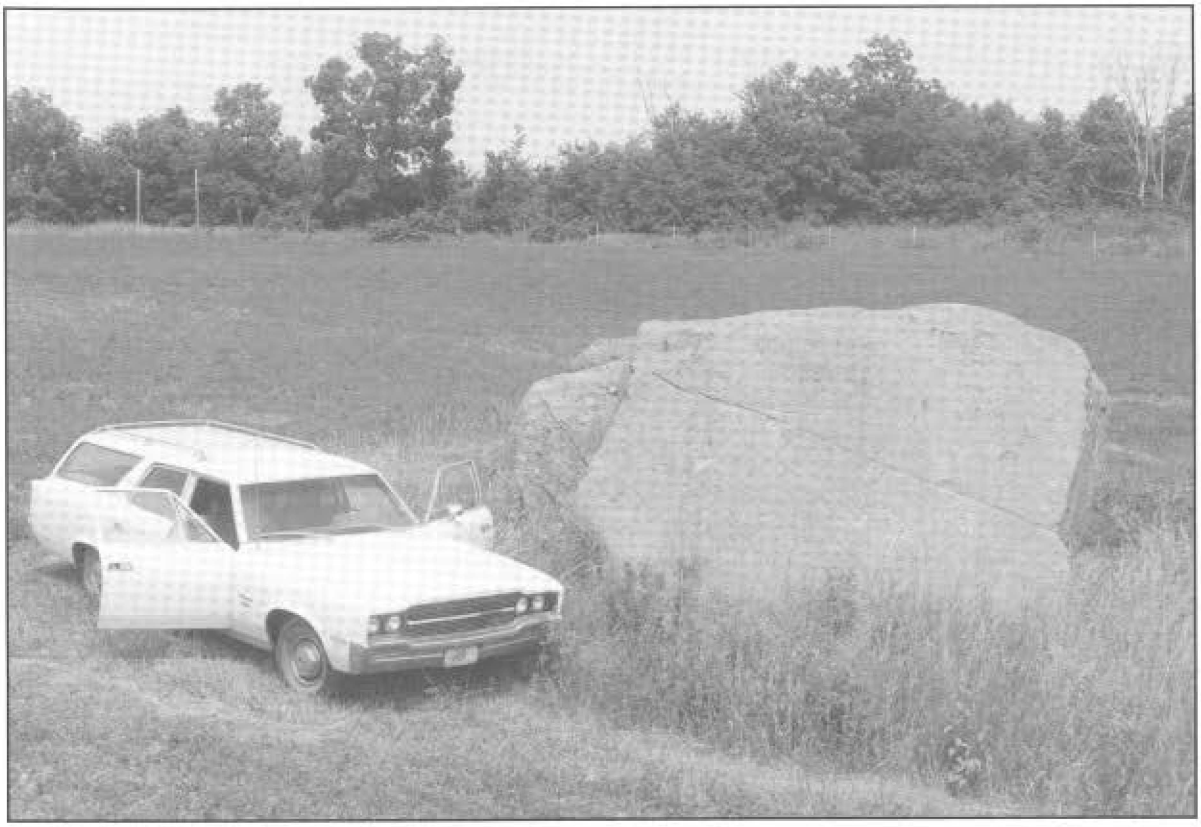


Figure 167

The Bairdstown Church Erratic, near Milan, is the largest and most perfectly preserved of any in northern Missouri. Photo by Jerry D. Vineyard.

367. BAIRDSTOWN CHURCH ERRATIC

Sullivan County, 8 miles northwest of Milan, near junction Highways OO and BB, in NE¼ SE¼ SW¼ SE¼ sec. 6, T. 63 N., R. 20 W., Pollock SW 7½-minute Quadrangle.

This glacial boulder is the largest and most perfectly preserved of any seen in northern Missouri. Thanks to its size, it was spotted 0.25 mile away from Highway OO, resembling a pink loaf of bread truncated on one end by a giant knife (fig. 167).

The boulder is pink granite in the form of a rounded prism 20 feet by 20 feet by 8 feet high. The height, of course, is only the exposed dimension, but a clue to its original minimal dimension is offered by a huge slice of granite which lies at the south end. This slice, like the heel of a gigantic loaf of bread, apparently fractured along the sheer south edge to enhance the resemblance to the sliced end of a loaf. The heel, with the "sliced" surface upward, is 10 feet by 17 feet, as viewed from above, and 3 to 4 feet of exposed thickness. An imaginary restoration of the heel to its original position gives some concept of minimum dimensions of the boulder. The exposed heel thickness of 3 to 4 feet adds that amount to the end of the boulder giving it minimum external dimensions (as viewed from above) of 20 feet by 23 or 24 feet. The minimum diameter of the heel (10 feet) gives a minimum height for the boulder of 10 feet. Thus, this reconstruction results in a boulder at least 10 feet high, 20 feet wide, and 24 feet long. These are still minimum dimensions and do not take into account the amount of rock lost by weathering at the time the heel split from the main loaf.

Drillholes on one corner of the boulder attest to attempts to make monuments out of the boulder. Several other large fragments of granite nearby attest to the splitting by weathering, probably through a combination of freeze-thaw activity of water in fractures and chemical decomposition. The calculated volume of 4,800 cubic feet is reasonable and using a weight of 160 pounds per cubic foot for granite, the calculated weight of the original boulder is at least 768,000 pounds or 384 tons.

Sample chips from this boulder were sent to the State Geologists of Minnesota and Wisconsin in an effort to determine the most southerly possible source.

The most southerly Minnesota source is the Sacred Heart Granite, 2.5 billion years old, which crops out in the Minnesota River valley, southwest of Minneapolis (Walton, 1975). This source is 300 miles north of Milan, Missouri. Walton states another possible source is in the vicinity of St. Cloud where 1.7 billion year-old granite crops out 375 miles north of Milan.

According to Ostrom (1975) the "Ruby Red" granite of the Wausau, Wisconsin area is the most southerly Wisconsin source. This outcrop is 380 miles northeast of Milan, Missouri. Wausau, Wisconsin is a little over 25 miles east of Milan, Wisconsin, suggesting some geographic-geologic atavism?

This boulder is so large and impressive that it merits preservation and due recognition. It is easily reached by taking Highway OO northwest from Milan for approximately 8 miles to the junction with Highway BB and then retracing the route on OO for 0.25 mile eastward to the Bairdstown Church (the church is erroneously called Blairstown on the Pollock SW Quadrangle). From the church, continue southeast for 0.1 mile and look obliquely to the left (east) in an uncultivated field 0.25 mile distant for the huge boulder. When the boulder is spotted and its position noted, return to the church and take a private road leading northeast past the church, following it for 0.3 mile after obtaining access permission at the first house beyond the church. Park and walk southeast to the boulder which is approximately 250 yards southeast of the private road.

368. COLLETT GLACIAL ERRATIC NO. 1

369. COLLETT GLACIAL ERRATIC NO. 2

Adair County, 2 miles southeast of Novinger. Marker boulder in NW¼ SE¼ SE¼ NE¼ sec. 4, T. 62 N., R. 16 W., Novinger 7½-minute Quadrangle.

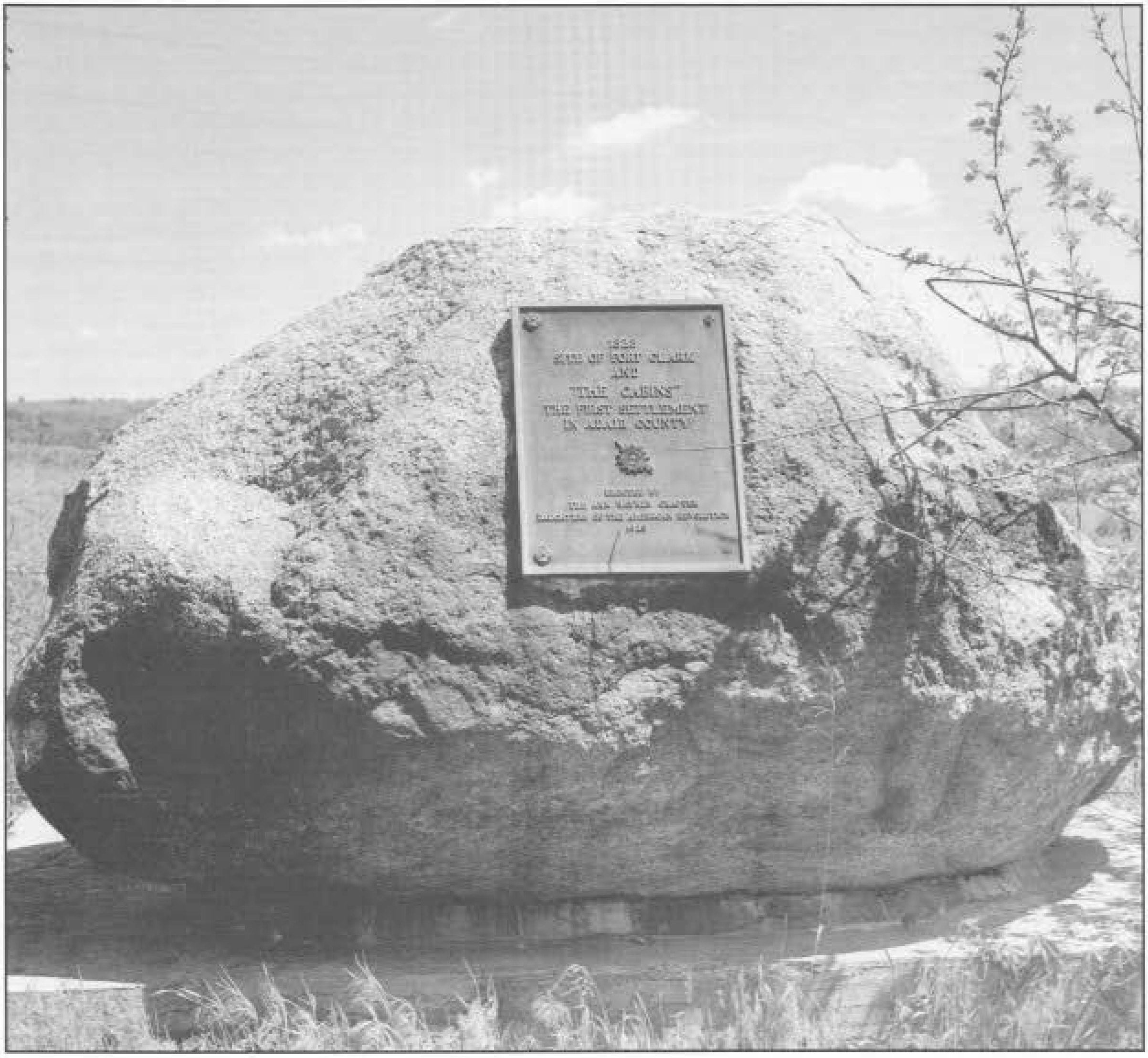


Figure 168

A red granite glacial boulder marks the site of Fort Clark and "The Cabins" (the first settlement in Adair County). Photo by Jerry D. Vineyard.

Two glacial boulders from the Collett farm have served as formal markers and at least one more remains near its original position. A tenth of a mile east of the bridge over Chariton River and a mile east of Novinger, a gravel road leads south 2 miles south of Highway 6. A red granite boulder (No. 368), 7 feet long and 6 feet in diameter, has been placed on a base and contains a plaque marking the site of Fort Clark and "The Cabins," the first settlement in Adair County (fig. 168).

The Collett family is a pioneer one in the area and occupies an antebellum home on the southeast side of the gravel road north of the boulder. West of the house across the road is a historic spring with a poem dated in the 1820's carved in the rock surrounding the spring. Hubert Collett states that a boulder of comparable size or larger is a mile east of the home and that the boulder used as a marker on the Northeast Missouri State University campus at Kirskville also came from his farm. The campus marker is nearly 3 feet in maximum diameter and a granodiorite, a close relative of granite, containing a higher percentage of dark minerals which give it a dark gray overall color. The granodiorite boulder (No. 369) is between Kirk Auditorium and the John R. Kirk Memorial. It contains a plaque marking its location near the east entrance of the original college building, having been donated by Hubert Collett from the first white settlement in Adair County and presented by the class of 1916. The historic buildings, springs, and past of the Collett farm as well as the hospitality of the owners made the visit one which was too short late in a July day.

370. HAMPTON BOULDER

(Description by Harry King*)

Ralls County, Old New London Gravel Road, 0.5 mile south of railroad crossing, center sec. 1, T. 56 N., R. 5 W., Hannibal 7½-minute Quadrangle.

The entire valley followed by the railroad running eastward into Hannibal is eroded through debris left behind by the melting of the Pleistocene glaciers. This debris has been used for a variety of purposes over the years, but none with as much history as the single erratic boulder known as the Hampton Boulder.

In 1905, Thomas A. Bacon wrote a short history of the Hampton Boulder for the *Hannibal Mirror:*

"South of Bear Creek, a road locally known as the Tadpole road, runs from the New London Gravel Road along the creek. On this route less than a half mile of travel brings one to a farm gate through which a wagon trail leads to a huge block of half buried red granite. Its shape suggests a rude cabin with gable end. In 1832 some utilitarian vandal drilled in the north end and blasted off fragments out of which he made two mill stones."

There is very good evidence that at least four millstones have been made from the Hampton Boulder. A small set of stones is now in the possession of Mr. Allen Eichenberger of Saverton, Missouri. In the opinion of this author, all of these stones were constructed from the granite of the Hampton Boulder.

The recovery of these three millstones involves a series of interesting occurrences. Very little is known of the actual mill which was located on nearby Bear Creek, but it was likely a small mill and could not have been too important in the commerce of Hannibal. The mill's mode of destruction is also unknown, but the millstones remained in the immediate area. For over half a century the stones lay covered by the gravel bars of Bear Creek until a local resident noticed a large iron bar protruding from the creekbed. The bar proved to be the spindle with the bedder stone still fixed to the buried end of the bar.

Two decades later, a relocation of Bear Creek chanced to uncover another millstone. Nearby was found the complete lantern gear with its slots for the spindle; later work uncovered the wheel hub and a portion of the wheel shaft.

The significance of an erratic boulder such as the Hampton Boulder is not so much in its size, shape, or location as in the important part it played in a lifestyle long since passed.

371. OLIVER GLACIAL ERRATIC

Mehl (1962, fig. 7) published a photograph of a huge glacial boulder fractured by natural causes to cover an area nearly 40 feet in maximum dimension. He stated that the granite boulder is on the farm of S.A. Oliver, Jr., northwest of Monroe City. No date is given for the photo and a half-day search for the site was fruitless.

Mehl's photograph is reproduced here (fig. 169); can any reader recognize it and tell us where it may be?

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*Formerly of the Department of Geography and Geology, Southwest Missouri State University, Springfield, Missouri

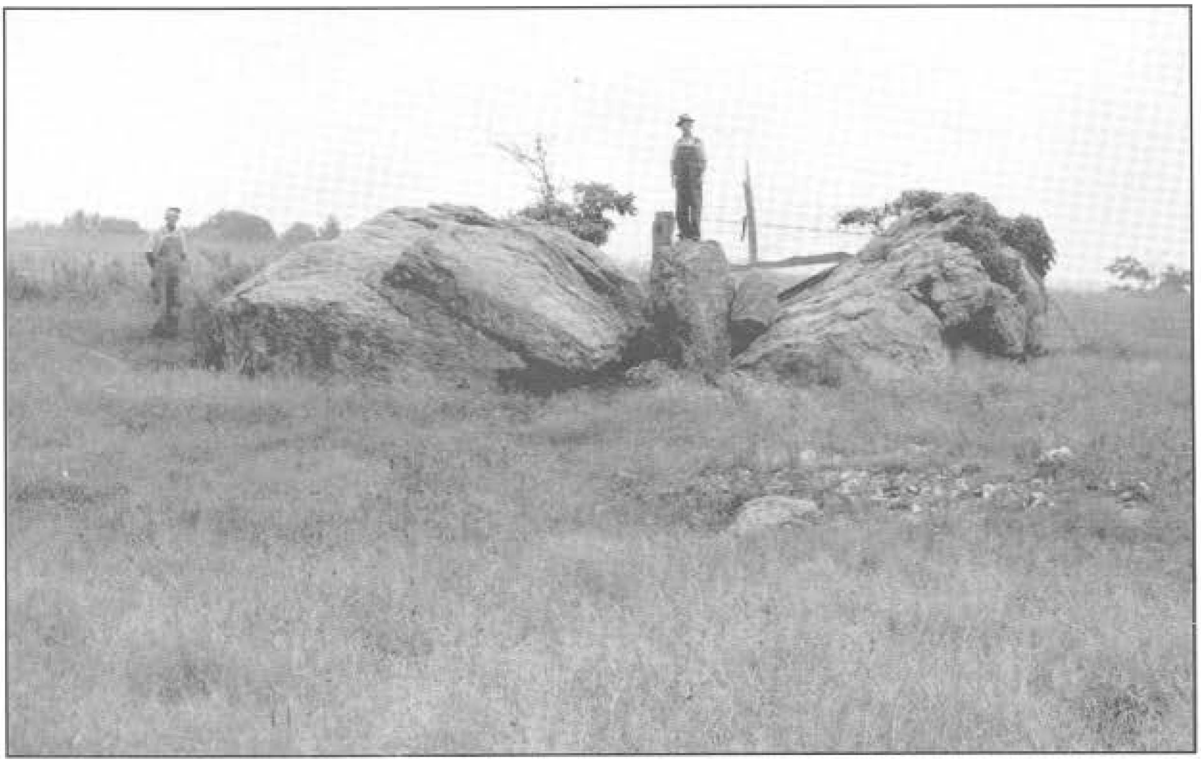

Figure 169

Large erratic (glacially carried boulder), one of the largest in Missouri. The boulder may have been situated northwest of Monroe City on the farm of Mr. S.A. Oliver, Jr.

372. VANDIKE FARMS ERRATIC

(Description by James E. Vandike*)

Schuyler County, approximately 4 miles northeast of Lancaster, in NE¼ SE¼ NW¼ SW¼ sec. 29, T. 67 N., R. 14 W., Bunker Hill 7½-minute Quadrangle.

This glacial erratic rests in the bottom of a small tributary of South Fork of North Fabius River. The quartzite boulder was moved a few years ago from the hillside about 200 feet east of its present position. The flat face of the boulder measures about 6 feet high and 5 feet wide. Length is about 8 feet. Maximum circumferences are 18 feet, 23 feet, and 19 feet. The weight is estimated to be between 15,000 and 20,000 pounds (fig. 170).

373. CARROLL COUNTY GLACIAL ERRATICS

(Descriptions by Mrs. Martha VanSooy*)

(a) Carroll County, Harry Hunzer Farm, 5 miles southeast of Plymouth, in SE¼ SE¼ sec. 32, T. 55 N., R. 25 W., Plymouth 7½-minute Quadrangle.

This boulder is quartzite (a metamorphosed sandstone) with dimensions of 12 feet by 9 feet by 3.5 feet. Digging in the ground shows that at least 2.5 feet of it is buried. Smaller pieces of quartzite are common in the field surrounding it.

From Carrollton it may be reached by the following route:

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*Missouri Department of Natural Resources, Division of Geology and Land Survey

*Carrollton, Missouri

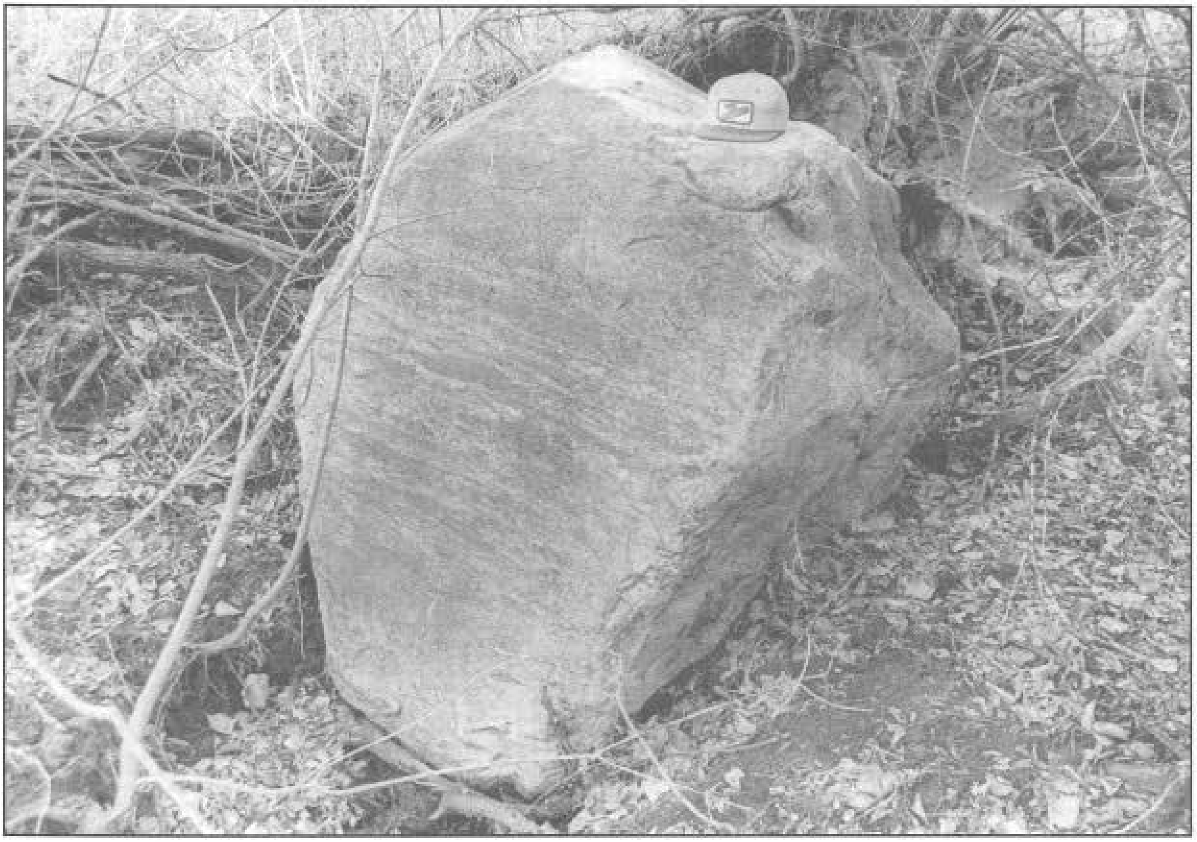


Figure 170

This large glacial erratic on the Vandike Farms in northeastern Missouri is typical of many such rocks that have been found and cared for by landowners. While some remain essentially where they were found, others have been moved to places where they can be seen and enjoyed. Photo by James E. Vandike.

Miles

0.5	*Junction of Highway 65 and East Fenton Street; go north on Highway 65.*
6.5	*Bogard Junction; take Highway A west through Bogard.*
18.5	*Junction with Highway D; turn north onto D.*
22.5	*Turn west (left) off D at church.*
23.5	*Turn north (right). Boulder is visible from road looking west immediately after turning north.*

(b) Carroll County, Wilma Rounkle Farm, 4.5 miles north of Coloma, in NE¼ NE¼ sec. 12, T. 55 N., R. 24 W., Coloma 7½-minute Quadrangle.

The Rounkle boulder is granite, approximately 5 feet long by 6 feet in diameter. In the field surrounding it are many fossil clams preserved as hematite.

The site may be reached by the following route:

Miles

0.0	*Junction of U.S. Highway 65 and East Benton Street in Carrollton. Go north on Highway 65.*
17.0	*Turn west (left) onto Highway U at Hale Junction.*
20.0	*Boulder is in field opposite (south of) residence about 0.5 mile in field.*

(c) Carroll County, Harold Miller Farm, 2 miles northwest of Bosworth, in SW¼ SE¼ sec. 9, T. 54 N., R. 22 W., Hale 7½-minute Quadrangle.

This quartzite boulder is approximately 5 feet square and visible from the road during the winter when not hidden by vegetation. It may be reached by the following route:

Miles

0.0 *At Bosworth, go west and thence north on Highway M.*

2.5 *Junction of Highways M and YY. Go north on YY.*

3.5 *Turn west of Highway YY and go west 0.25 mile. Boulder in field to right.*

(d) Carroll County, Merrill Meyers Farm, 2 miles east of Bosworth, in NE¼ NE¼ sec. 30, T. 54 N., R. 21 W., Bosworth 7½-minute Quadrangle.

This boulder is andesite, a rock which is similar to rhyolite, but has a higher proportion of dark-colored minerals. It is approximately 6 feet square and not visible from the road. It may be reached via the following route:

Miles

0.0 *Junction of Highways 139 and M at Bosworth; go east on M.*

2.0 *Turn south (right) onto gravel road, cross bridge, and go uphill. Erratic is in cultivated field to right (west) about 0.25 mile from road.*

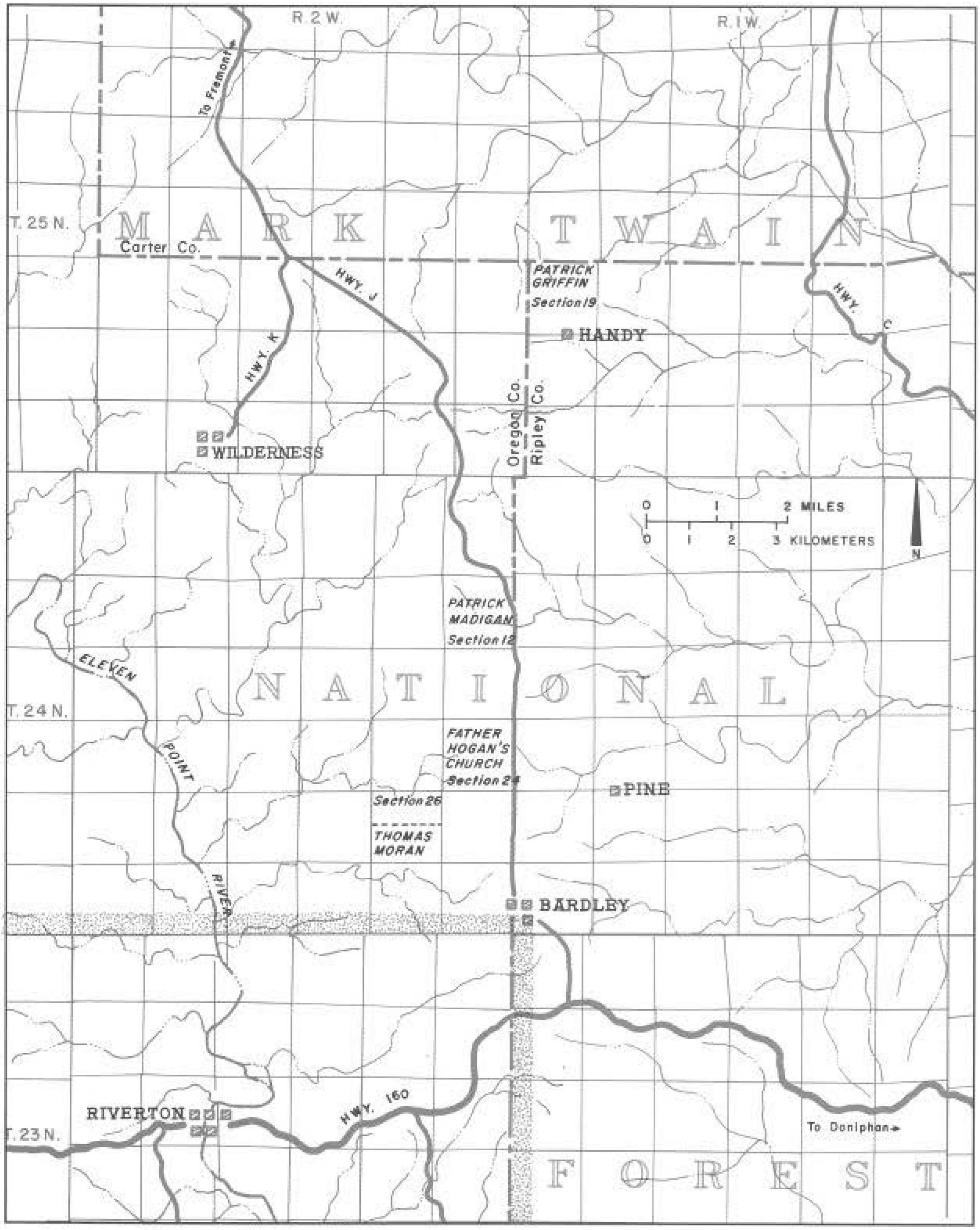

R.2 W.
R.1 W.
To Fremont
T.25 N.
MARK TWAIN
Carter Co.
HWY. J
PATRICK GRIFFIN Section 19
HWY. C
HANDY
HWY. K
Oregon Co.
Ripley Co.
WILDERNESS
0 1 2 MILES
0 1 2 3 KILOMETERS
N
PATRICK MADIGAN Section 12
ELEVEN POINT RIVER
NATIONAL
T.24 N.
FATHER HOGAN'S CHURCH Section 24
PINE
Section 26
THOMAS MORAN
BARDLEY
RIVERTON
HWY. 160
T.23 N.
To Doniphan
FOREST

Figure 171

The Irish Wilderness

13

Potpourri

374. IRISH WILDERNESS

In vicinity of common corners of Ripley, Carter, and Oregon Counties, south of Fremont and northwest of Doniphan, refer to Bardley, Handy, Riverton, and Wilderness 7½-minute Quadrangles.

The Irish Wilderness is not geologically unique, but it is unusual because of its sparse settlement, isolation, and the enigmatic history (or lack thereof) of a settlement which vanished. The general area is south of Fremont and northwest of Doniphan in the vicinity of Highway J, north of Highway 160 and east of the Eleven Point River (fig. 171).

In 1858 and 1859 Father John Joseph Hogan and approximately 40 Irish-Catholic families settled in the area, but with the exception of Patrick Griffin nearly all of the settlers left during the Civil War. According to Saults and Wooldridge (1951, p. 12), Griffin:

"...joined the Confederates and fought under General Marmaduke. It was a long war; when Billy got home he was grown up — and Father Hogan's Settlement was gone! Only Patrick Griffin and his wife were still there, and they were near starvation. Bushwackers had looted the granaries, stolen all the livestock, harassed the Irish until they retreated northward into the protection of Union lines around Ironton. They had been living, unfortunately, in the middle of a battleground.

"That was the end of the Settlement — but not of young Griffin. After moving his parents to Ironton he came back to Carter County, carved from northern Ripley in 1859. It may have been a return because nobody could shove him about...but he had met a young widow, Mary Ann Vincent Snider, and her two children. Billy married Mary Ann and lived happily for a half-century."

Saults and Wooldridge state that Patrick's land was in sec. 19, T. 25 N., R. 1 W., where the Handy Post Office (rated the smallest post office in the country with dimensions of 6 feet by 9 feet) was also located.

Saultmore (1977, p. 17-19) has updated some of the views on the history of the Wilderness.

Simpson (1971, p. 31-32) gives other land holding locations as shown on fig. 171 and indicated that Father Hogan's church was in the east half of sec. 24, T. 24 N., R. 2 W. Accuracy of his research is further documented by Campbell (1874, p. 32) whose map shows "Father Hogan's Settlement" in sec. 25 of the same township and range. Because the Campbell map was somewhat generalized, it can be considered as confirming rather than detracting from Simpson's evidence.

Wihebrink (1970, p. 20 and 60), in his detailed history of the settlement, located the church in SW¼ SE¼ sec. 24 on the Clyde Anderson farm and states (p. 20) that *"the* *foundation has been ploughed out in recent years."*

These dates leave a somewhat confusing picture regarding the Confederate or Union sympathies of the settlement and such may have been the case as it was with the many tragedies resulting from divided sentiment in Missouri. Records strongly suggest that the settlement moved (or was moved) to Pilot Knob in October 1863.

The outer boundaries are vague but certainly the triangle formed by Wilderness, Handy, and Bardley would be a fairly accurate minimum area.

375. LOESS BADLANDS

Howard County, northeast of Boone's Lick State Park, on Highway 87, 0.8 mile north of Highway 187 junction, in SW¼ SW¼ SW¼ sec. 28, T. 50 N., R. 17 W., Franklin 7½-minute Quadrangle.

This site in the southwest corner of Highway 87 and a crossroad junction is a small-scale version of Midwestern badlands. It results from intense erosion and gullying of loess and underlying sand to produce sharp pinnacles and ridges, some as much as 30 feet high. These vertical slivers, so thin that they appear to defy wind and gravity, are excellent photographic subjects (fig. 172). The best time for photography would be during the winter when the sun is to the south or southeast. The ability of loess to cohere in vertical faces is especially well demonstrated in this amphitheater at the head of a valley. A visit to the geologically and historically significant salt springs at Boone's Lick State Park might well be accompanied by a stop at these badlands.

376. DEVILS COURTYARD

Buchanan County, in east bluff of Missouri River valley, 2 miles south of Rushville, in NW¼ NE¼ NE¼ NW¼ sec. 27, T. 55 N., R. 37 W., Atchison East 7½-minute Quadrangle.

This exposure, herein dubbed the Devils Courtyard, is not completely natural but exists because of quarry operations in a flat-lying limestone containing a geometric set of vertical fractures. These fractures are so evenly spaced and so remarkably parallel to one another that the floor of the abandoned quarry has the appearance of having been laid by a master stonemason. Plant growth along the fractured, slabby rock accentuates the parallel lineation. The exposure would best be photographed in winter when growth is not so abundant.

The rock is a limestone of the Shawnee Group, Pennsylvanian in age. The exposure would be *de rigueur* for any structural geology class field trip and should also be impressive to the layman in showing the geometric arrangement of fracture systems with the realization that such fracture systems are a major factor in determining topographic features where bedrock is predominant.

From the junction of Highways 45 and 59, 2 miles south of Rushville, drive due east for .05 mile, bear right and drive south for 0.15 mile and then turn sharply left, climbing a gravel road for a bit under 0.2 mile. At this point, note on the left (north) a fenced-over entrance road which once led to the quarry. Follow this for about 100 yards to the Courtyard.

377. BIG OAK TREE SWAMP (JDV)

Mississippi County, 4 miles east of Bayouville, in Big Oak Tree State Park, N½ sec. 14, T. 23 N., R. 16 E., Bayouville 7½-minute Quadrangle, on which it is shown.

In pre-settlement times, much of the Bootheel of southeastern Missouri was a vast swampland. Settlers saw the promise of rich agricultural lands, and drained the swamps. For many years, cotton was king in the Bootheel, but today other crops are dominant, and vestiges of the once-vast swamplands are small and few in number.

Big Oak Tree State Park is one of the largest remnant swamplands remaining in Missouri, and certainly the most fascinating. Swamps do not normally enjoy a high tourist rating, but at

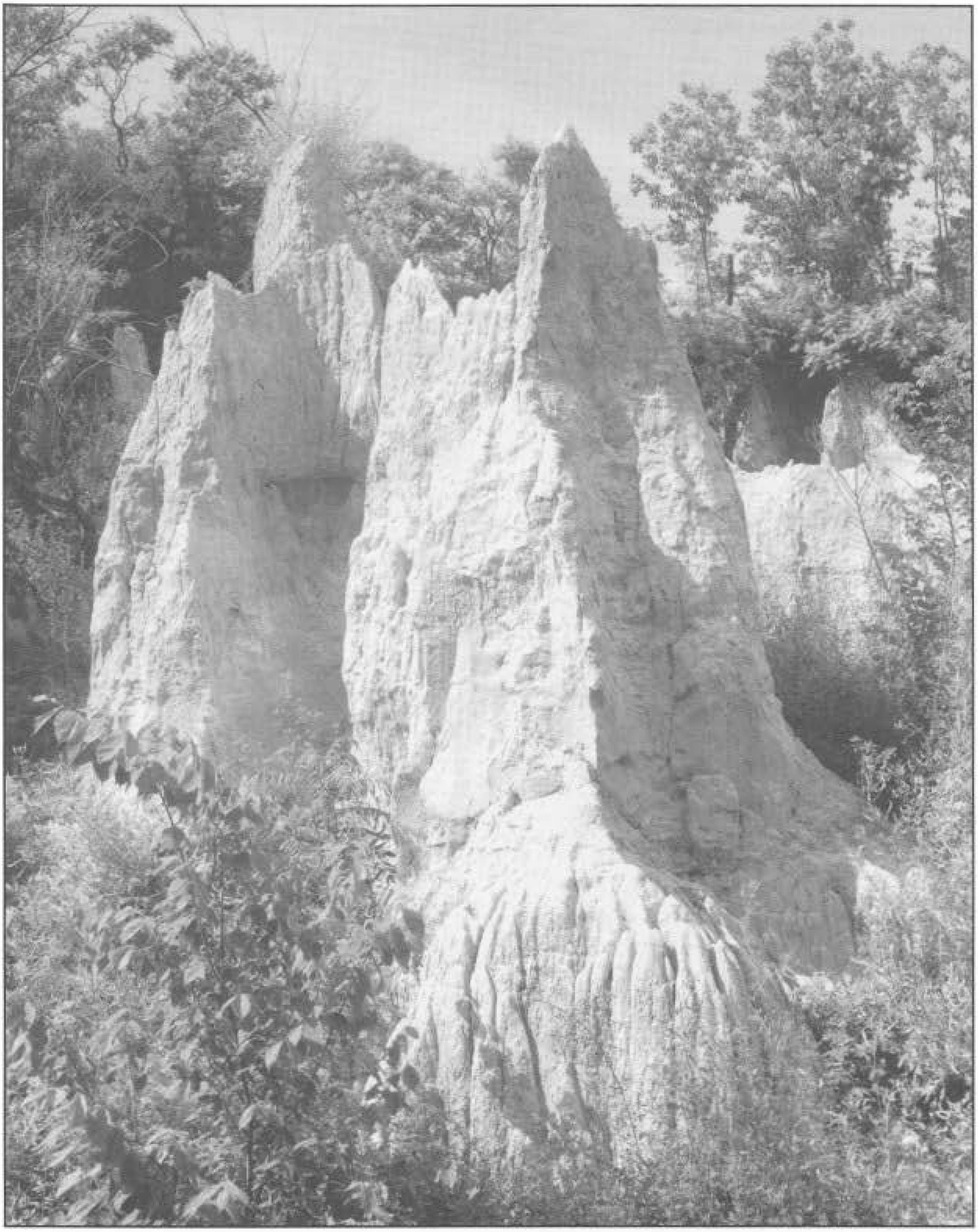


Figure 172

Thin vertical loess slivers appear to defy gravity in the Loess Badlands. Photo by Jerry D. Vineyard.

Big Oak Tree, a sturdy boardwalk set on pilings winds its way for a half-mile or so into the heart of the swamp, where big oak trees share the space with giant cypresses (fig. 173), a national champion slippery elm, and many species of wildlife.

Should you walk the boardwalk in any season except winter, be prepared for pesky mosquitos; the feathered flying fauna, though, will be delightful (fig. 174).

The peacefulness of the alluvial plains of the Bootheel was rudely shattered by the great New Madrid earthquakes of 1811-12, when the ground trembled and shook throughout southeastern Missouri and northeastern Arkansas. The shocks were so powerful that they rang church bells as far away as the East Coast. Two waterfalls formed in the Mississippi River, and Reelfoot Lake in Tennessee was formed by subsidence of the land.

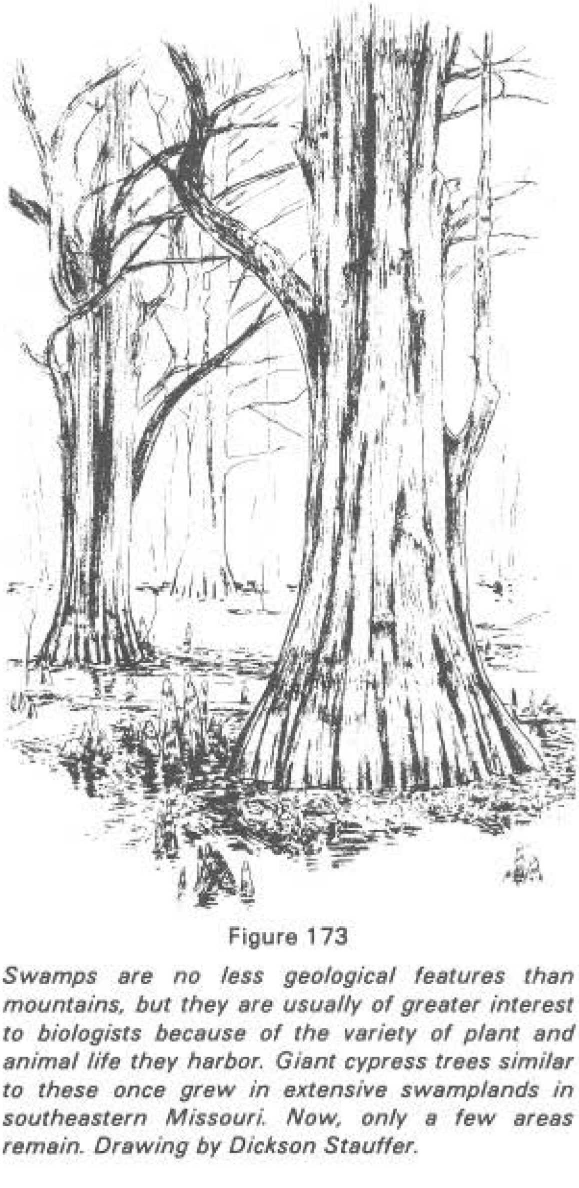


Figure 173

Swamps are no less geological features than mountains, but they are usually of greater interest to biologists because of the variety of plant and animal life they harbor. Giant cypress trees similar to these once grew in extensive swamplands in southeastern Missouri. Now, only a few areas remain. Drawing by Dickson Stauffer.

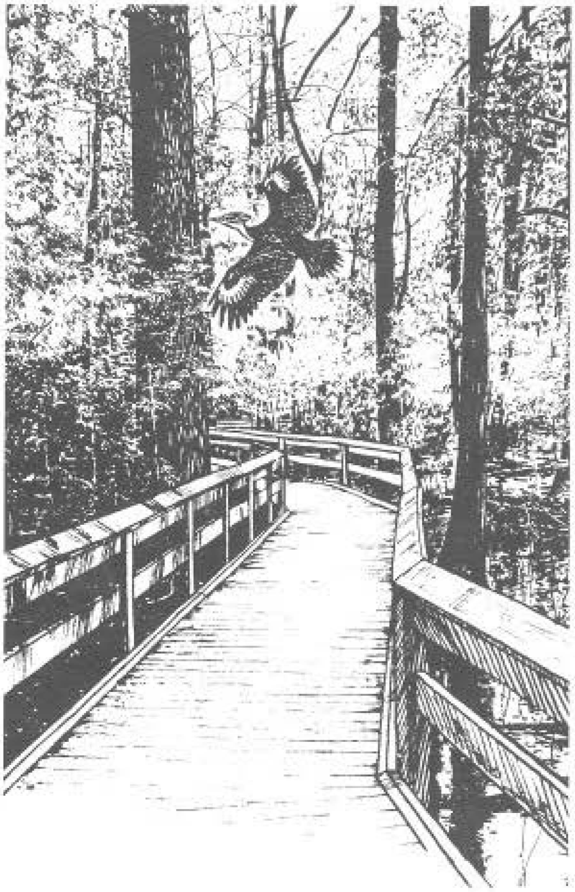


Figure 174

A sturdy boardwalk provides access to the deep swamp at Big Oak Tree State Park near Bayouville, in the Missouri Bootheel. In the absence of a walkway, few people would ever see beyond the fringes of the place where some of Missouri's champion trees rise from marshy ground to produce a jungle-like setting. Drawing by Dickson Stauffer.

Today, earth tremors still alert the populace to the potential for another devastating earthquake and prompt seismologists to monitor tremors carefully and to try to develop more accurate predictive capability.

Big Oak Tree State Park is not in a heavily traveled area, but it is well worth driving east on Highways WW and 102 from New Madrid, to experience the boardwalk. Nearby is Towasaghy State Historic Site, where the remains of a once-fortified Indian village may be seen. In New Madrid, the Hunter-Dawson Home State Historic Site preserves the flavor of the past in a white antebellum mansion typical of elegant homes that were once common along the "Great River Road."

378. GLACIAL GRAVELS

Marion County, in Hannibal, on Business 61, from 2500 through 2900 block of Market Street, in E½ sec. 31, T. 57 N., R. 4 W., Hannibal East 7½-minute Quadrangle.

Glacial meltwater was responsible for deposition of many of the commercial sand and gravel deposits of the Midwest and one of the best examples of such a meltwater deposit is along Business Highway 61 which approaches downtown Hannibal from the southwest. As you drive toward the business district, note that from the 2900 to the 2500 blocks of Market Street, inclusive, extensive gravel operations utilize a deposit with a thickness estimated as great as 75 feet. These gravels, carried by glacial meltwaters flowing down the Mississippi, formed thick deposits at many areas in the Mississippi valley, including those at Wakonda State Park south of LaGrange. At the time the Wakonda deposits were commercially worked, workers found occasional Lake Superior-type agates among the gravels as well as an occasional live fish bonus on the conveyor belt carrying the gravels to the screen from beneath the surface of the water. Because such gravels came from a great variety of sources, one can expect a great variety of rock types at both Wakonda and Hannibal. Any geologist who can identify a bushel basket full of random pebbles from these gravel deposits should feel exceptionally confident in rock identification.

The brown color of the Hannibal sand and gravel results from the deposition of the iron oxides, and the variability in sand-gravel distribution is the result of the deposit being emplaced in a stream environment.

379. SHAKING MOUND SPRING

Greene County, 5 miles northeast of Halltown, near center west line NW¼ sec. 15, T. 29 N., R. 24 W., Halltown 7½-minute Quadrangle.

Shaking Mound Spring was not visited and we are indebted to Shepard for information regarding it. Because his report has long been out-of-print, it is appropriate to cite his description from it (1898, p. 229). He states that the spring

> *"...has long created considerable interest throughout the region in which it is located, and has been the subject of some comment in the newspapers."*

He further states:

> *"Here the water rises from the summit and seeps off all over the low mound, which is twelve feet high, and fifty by seventy feet in dimension. The mound stands in the river bottom, not far from the junction of Pickerel and Pond Creeks, and is most remarkable, from the fact that it shakes all over when walked upon. Poles are easily sunk in it, through the tenacious turf, and down to a distance of six to ten feet, into the black muck that makes up the bulk of the mound. A dense mat of grass and sedges covers the mound and remains green the whole year. Cattle are frequently mired in the bog. This would, undoubtedly, be a good locality in which to search for the remains of extinct animals, such as the mastodon, and it is a rare example in the south, of the peat bog which is not uncommon in the more northern regions."*

380. EUDORA SPRING PARK

Polk County, in SW¼ SW¼ SW¼ sec. 13, T. 32 N., R. 24 W., 1 mile northeast of Eudora and 6 miles north of Walnut Grove, Walnut Grove 7½-minute Quadrangle.

A photograph taken during the 1880's or 1890's shows an attractive Eudora Spring Park with summer cabins and picnic decks interspersed among pinnacles of Burlington

Limestone near the top of the bluff along the spring branch. Today the area is overgrown with brush and weeds and is not particularly scenic, but the combination of the spring, spring branch, and pinnacled Burlington make it a promising recreational area.

381. DEVILS POOL (JDV)

Taney County, 4 miles south-southeast of Table Rock Dam, on an arm of Table Rock Lake, in SW¼ NW¼ NE¼ SW¼ sec. 12, T. 21 N., R. 22 W., Table Rock Dam 7½-minute Quadrangle, on which it is named.

Devils Pool, now flooded by Table Rock Lake, was a spring that rose from a dark-blue pool in a steep-walled hollow. In the early 1900's the place was called Devils Hole (Van Buskirk, 1976), but the name was changed in 1927 to highlight a dude ranch, said to be the first in the Ozarks. Waters of the spring were used to irrigate acres of lawns and gardens, which required so much water that the owners tried unsuccessfully to increase the flow by cleaning leaves and dirt from the spring.

Devils Pool is now surrounded by an extensive residential development adjacent to Table Rock Lake, and the rise pool of the spring lies several feet below the lake surface.

382. THE RIFLE HOLES

Pulaski County, on west side of Highway 28, in bluff of Gasconade River, midway between Waynesville and Dixon, in center S½ SW¼ SW¼ SE¼ sec. 23, T. 37 N., R. 11 W., Dixon 7½-minute Quadrangle.

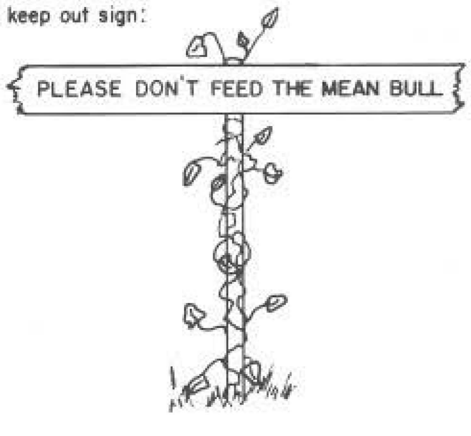
The Rifle Holes are tubular openings averaging between 1 and 2 feet in diameter in the face of a bluff of upper Gasconade Dolomite. Accompanying these openings is a cave entrance, between 3 and 4 feet high and 2 feet wide, which enters the bluff at right angles to the face and then makes a sharp 90° turn to the right to parallel the face back of the Rifle Holes (fig. 175). The lack of a flashlight and the poor housekeeping practices of the cave's animal tenants discouraged exploration to see whether Rifle Holes connect with the system.

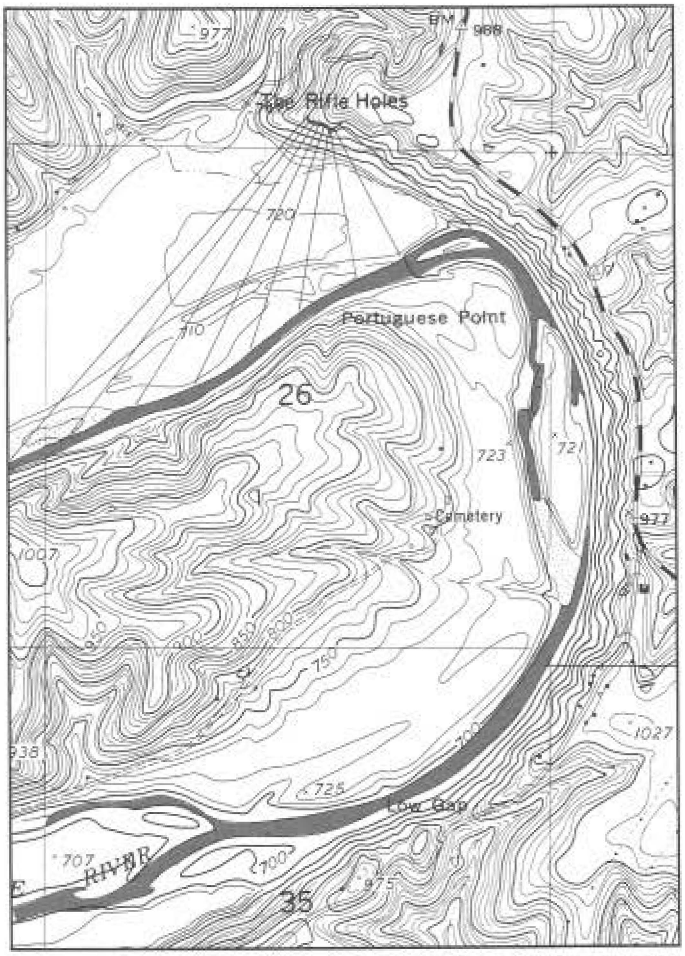
Tradition has it that Indians armed with rifles would enter the cave and use these ports to fire in comparative security. The tradition poses the paradox of an anachronism as well as a physical problem of bending the rifle barrels sufficiently to use the rather crooked ports.

The site is fairly popular as indicated by a path along the bluff but its attractiveness drops considerably when the temperature is above normal.

The Rifle Holes are on private land, so be sure to obtain access permission before visiting. They were reached by driving north on Highway 17 from Waynesville and parking at Portuguese Point 1.5 miles north of the bridge across the Gasconade. (Portuguese Point is a well-marked and well-known scenic overlook. The valley flat of the Gasconade below this overlook reportedly had a small settlement of Portuguese, thus the name.) From the point, walk 0.15 mile to the northwest to a section line fence running west. Follow an open area in the woods to the right or north of the fence to the bluff into an area of cedar trees with a path leading down to a sharp ravine in the bluff. The Rifle Holes are on the southeast side of this ravine where the bluff forms a sheer face and the path leads downward to the Rifle Holes and around the corner to the left to the bluff face paralleling the river.

Effective keep out sign:


PLEASE DON'T FEED THE MEAN BULL


977
BM 988
The Rifle Holes
720
710
Portuguese Point
26
723
721
Cemetery
977
1007
750
1027
938
725
Low Gap
707
RIVER
700
975
35

USGS Dixon 7½-minute Quadrangle

From a military viewpoint, The Rifle Holes could sweep a wide arc of a "moccasin bend" on the Gasconade River, giving cover to a band of crack shots. However, actual use of these natural gunports is more fancy than fact. What a great place for small boys!

GROUND PLAN OF THE RIFLE HOLES

There are a total of nine holes or "gunports" connected by a stoopway access passageway, just wide enough to admit a (small) man.

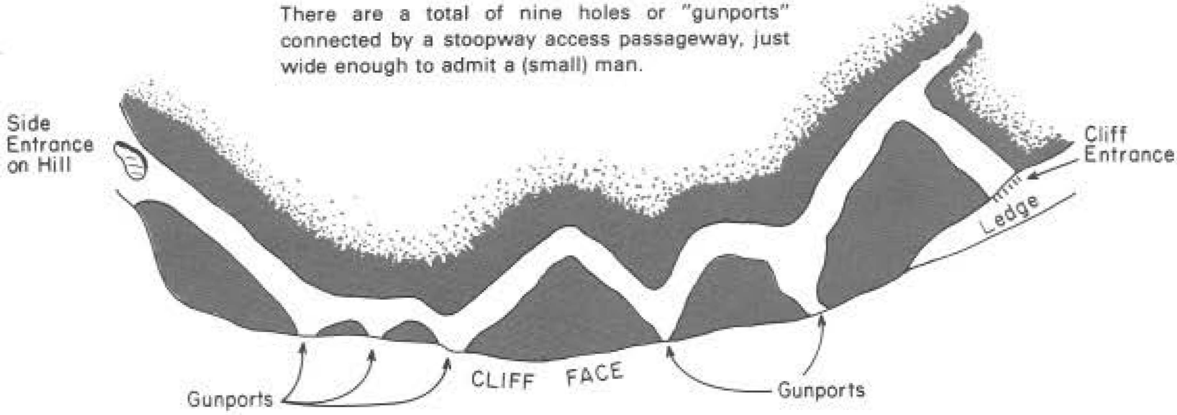

Side Entrance on Hill
Cliff Entrance
Ledge
Gunports
CLIFF FACE
Gunports

Figure 175
The Rifle Holes in Pulaski County.

383. ELEPHANT WALK (JDV)

Taney County, 3 miles west-northwest of Hercules Lookout Tower, in the Hercules Glades Wilderness of Mark Twain National Forest, on the Pilot Knob Trail, in SE¼ SW¼ NW¼ SW¼ sec. 3, T. 23 N., R. 18 W., Hilda 7½-minute Quadrangle. (Refer to fig. 176).

Did some ponderous, puddle-footed pachyderm pass this way? It surely *looks* that way. Across the trail (actually an old road) hundreds of depressions in solid rock resemble fossilized elephant tracks. Indeed, it looks as though a whole herd, complete with baby elephants, lumbered across.

The explanation is not that simple. If you look carefully, there are depressions and correlative lumps or nodes. Look carefully at the nodes and you'll see that they vary from apparently solid, to loosened around the rims, to those already weathered free; in fact, you can lift a "track" out of its socket. They are actually primitive algal colonies from an ancient sea floor, far from elephant country. Among the most primitive forms of life, these colonies grew on the ancient sea floor some 450,000,000 years ago.

The strange part of the story is that there *were* elephants here during the Ice Ages, as proven by the many elephant bones found elsewhere in Missouri. But when they were here, the "footprints" were already there.

The Hercules Glade Wilderness has a well-developed trail system well worth the time to explore. Devils Den (No. 99) and Mosstone Falls (No. 106) are reached from these trails, which pass through some of the most spectacular glade country of southwestern Missouri.

384. EARTHQUAKE HOLLOW (JDV)

Callaway County, off Highway TT, 2 miles southeast of New Bloomfield, in SE¼ SW¼ sec. 4, T. 45 N., R. 10 W., New Bloomfield 7½-minute Quadrangle.

Earthquake Hollow is unlike any other place in Missouri. It is aptly named, at least from first impressions, because it certainly *looks* as though a mighty earthquake ripped through this part of Callaway County and tumbled giant boulders down a hillside.

A farm road leads to this privately owned place. Where the road ends there is a cleared area with a trash barrel, so the place seems more free of litter than it might otherwise be. From the cleared area, one walks immediately onto the tops of huge boulders that, on closer inspection, prove to be chunks of a massive rock layer ribboned by large cracks that have widened to form crevasse-like gaps between the boulders, some of which are chunks of rock more than 50 feet long, 20 feet high, and 10 to 20 feet wide. Together they are an impressive jumble of megaboulders that could be considered a Callaway County version of the Elephant Rocks, though their origin is entirely different. In fact, for the young and adventuresome, this place is almost equal to Elephant Rocks for playing hide-'n-seek, cowboys and indians, or lawmen and robbers.

Though the esthetic experience and the visual impact is similar to what one receives at Elephant Rocks, the differences are basic and substantial: first, a different physiographic province, the Glaciated Plains of north Missouri versus the St. Francois Mountains of southeastern Missouri; second, sedimentary rocks of the Pennsylvanian Graydon Formation versus Precambrian Graniteville granite; third, solution sapping and subsidence versus weathering along joints and rounding at joint intersections; and finally, private ownership versus State Park ownership.

To a geologist, the most fascinating aspect of Earthquake Hollow is the rock itself, the Pennsylvanian Graydon formation, a heterogeneous mixture of sand, gravel, and boulders. The spectacular rock exposures here indicate a high-energy depositional environment where boulders could be tumbled along in rushing water, their edges rounded by collisions with one another. Examination of the megaboulders shows that some are composed primarily of well-sorted sandstone layers, whereas others are partly sandstone and partly conglomerate. Some of the conglomerates could be called boulder conglomerates because of the large

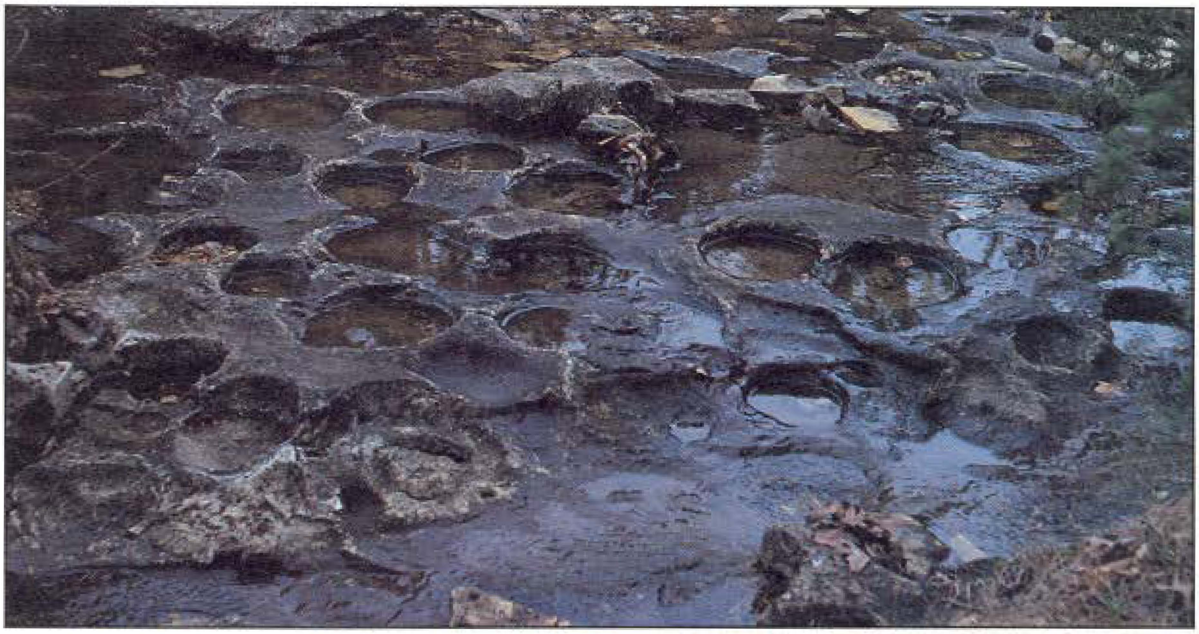


Figure 176a

The "Elephant Walk" appears to be a place where a herd of elephants walked across a muddy stream course. In fact, the stream flows on solid rock pitted by fossil algal colonies that date from the Ordovician Period, hundreds of millions of years before elephants appeared. Photo by Jerry D. Vineyard.

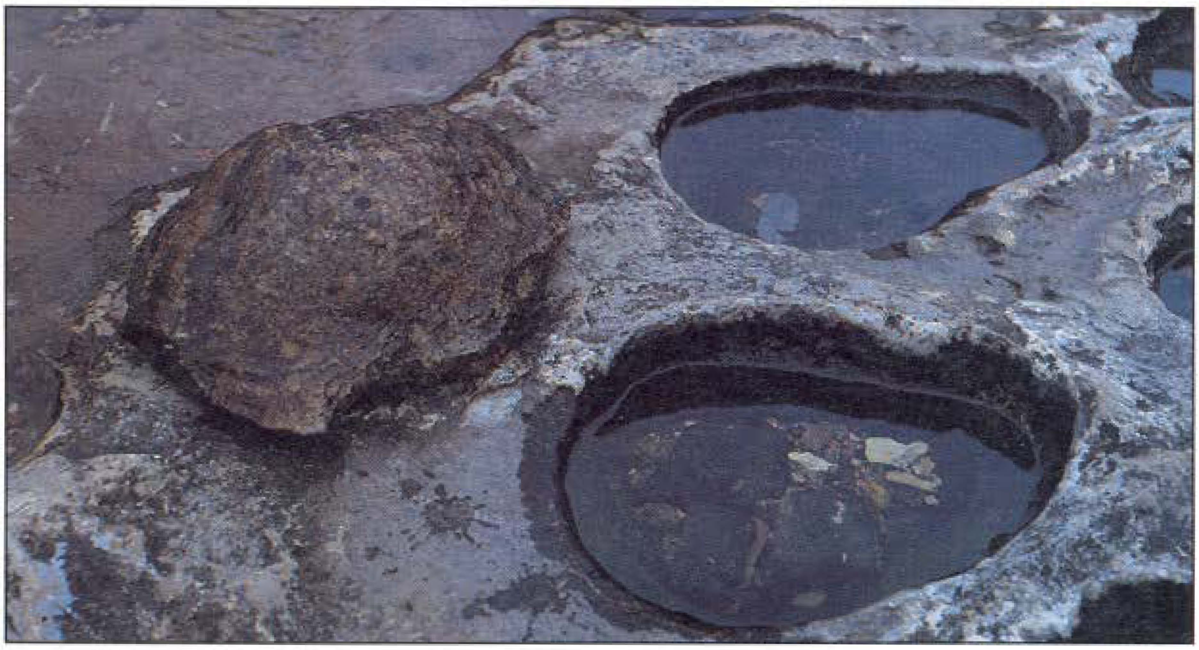


Figure 176b

Close inspection of the "elephant tracks" show them to be molds of algal colonies remaining after the fossil colonies weather loose and are washed away by the stream in flood times. A colony still in place is on the left. Photo by Jerry D. Vineyard.

size of the individual fragments. The whole mass is cemented to form a rather tough rock, which has resisted erosion more successfully than the underlying formations. The latter apparently have been sapped by solution, thereby allowing the more resistant overlying Graydon Formation to break apart because of its own weight, and the megaboulders to slide downhill, thus giving the distinct impression that a great earthquake once shook the countryside.

Earthquake Hollow is actually in two parts. From the boulderfall one can look across the valley to another barren rock exposure of the same material, but its recent geologic history has not been the same. On the opposite side of the valley, instead of great boulders scattered over a hillside, there is a prominent rock bluff in which pinnacles and spires have developed by erosion.

The relief between the water level in the intermittent stream flowing through Earthquake Hollow and the top of the cliff is 130 feet, of which more than half is the thickness of the Graydon Formation in this area. The top of the massive bluffs on the opposite side of Earthquake Hollow is about 10 to 15 feet higher than the top of the boulderfall on the boulder side of the valley. The bluff top is covered with a scrubby forest of miniature blackjack trees, some of which must be very old because of the extremely adverse conditions under which they exist. The soil is thin to almost nonexistent, extremely rocky (cherty), and the place almost always seems to be windswept. Other than the scrubby blackjack, little else but lichens and mosses grows on the rocky heights.

On the more moist side of the bluffs, ferns grow in great abundance, often favoring convenient niches left when boulders weathered out of the overhanging rock face. The whole area is a lichen-lover's paradise, with the gray colonies giving a look of character and great age to the stark rock outcroppings. There are geology lessons everywhere, whether you stand back and look from afar at the jumbled strata or whether you stand close and look for the many fossils in the individual rocks. What conditions existed when these sediments were deposited? How old are the deposits? Where did the individual rocks come from, and what moved them to this site? What animals became the fossils we see today? What are the forces that worked in breaking down this geologic feature, making it sediment once again in the inexorable march of time? What role does plant life play in the breakdown of the rocks? These and other questions come to mind as one ponders the why of Earthquake Hollow. Are there any other places like it in Missouri? Probably, but this is the only one we know of, and it is embarrassing to note that even this one missed the first edition of Beveridge's *Geologic Wonders and Curiosities of Missouri.*

The photographer will be impressed here, yet immensely frustrated. There are so many trees on the lower slopes that it is hard to back away to get an overall view of the megaboulders. This can be done best only in winter, fall, or early spring, and a wide-angle lens would definitely be an asset.

From Jefferson City, drive north on Highway 54 to Highway TT. Turn right on TT and drive 1 mile to a junction with a county road. Turn left on the county road, and drive 0.9 mile to a lane on the left, crossing an open field. Follow the lane about 0.2 mile to the parking area for Earthquake Hollow.

385. STAIRSTEP SWIMMING HOLE

Wright County, on Whetstone Creek, 1 mile east of Owens and 8 miles east of Hartville, in NW¼ SE¼ NW¼ NE¼ sec. 8, T. 29 N., R. 13 W., Owens 7½-minute Quadrangle.

This site is not as unusual geologically as its intriguing name suggests. It is, however, attractive and was identified by Butler (1934) on the Wright County map in the Depression era series of county maps he compiled noting points of interest.

The pool is obviously popular and earned its name (as did Whetstone Creek) from the scenic ledges of Roubidoux sandstone which jut from the banks. The stairstep effect of these ledges is not pronounced as the name implies and the site is not particularly photogenic. It is a tempting and well-used swimming and picnicking area.

It is easily reached from Owens on Highway E midway between Norwood and Highway 38 east of Hartville. From Owens, go east by northeast on a gravel road for 1.15 miles to where the road turns north. Continue east by southeast from this turn for 0.2 mile where a low-water bridge crosses Whetstone Creek. Cross this bridge and continue southeast 0.05 mile to a second crossing over a tributary. Park near this bridge and walk southwest approximately 100 yards to Stairstep Swimming Hole.

386. HUZZAH CANYON

Madison County, on north side of St. Francis River, 5 miles north of Lodi, in N½ NE¼ sec. 36, T. 31 N., R. 5 E., Coldwater 7½-minute Quadrangle, on which it is named.

This small but impressive canyon plunges from an elevation of about 600 feet above sea level to river level at about 430 feet in less than 0.5 mile. A small spring at the head of the canyon contributes to permanent flow in Huzzah Creek from that point, through the canyon to the St. Francis River.

387. MASTODON STATE PARK (JDV)

Jefferson County, 1 mile west-northwest of Imperial, on west side of I-55, in NE¼ sec. 18 (projected), T. 42 N., R. 6 E., Maxville 7½-minute Quadrangle.

At an obscure and much-used spot in Jefferson County near the villages of Kimmswick-Imperial, men saw fleeting glimpses of beauty. A showman-boneman saw profit in the huge bones he found there in the early 1800's. A procession of paleontologists followed their vision of a treasure trove of old bones to enrich their universities and museums. A quarryman saw economic gain in good stone from the site. Archaeologists glimpsed a link between their ancestors and the great elephants of the Ice Age. The Highway Department sensed a profit in selling the land for development, but a group of housewives saw beauty in an overgrown tract that would become a state park for all of the people.

The Kimmswick paleontolgoical site has been known since about 1830, when Albrecht Koch of St. Louis found many bones there. The monster he created from the bones (he also used some bones from other sites) was half real, half fantasy, because Koch was a showman first and a paleontologist part-time. He called his beast *Leviathan Missouriensis,* and showed the bones worldwide. Later, when he had milked the profit from the idea, the British Museum acquired the collection and assembled the true beast, *Mammut americanum* (fig. 177), which is still on display in all its glory (McMillan, 1976).

After more than 140 years, the Kimmswick site is well-nigh unrecognizable, having been pillaged by souvenir hunters, quarrying, highway construction, and other assorted indignities. Scant clues remain as to why the bones were there in the first place. Were there ancient salt springs there that lured the mighty elephants to the mire, from which they could not escape? Was it a kill site for ancient man? What makes this site, so similar to hundreds of others in the region, different? We probably shall never know the answers to these questions, because the bones have been scattered far and wide, and more important, the knowledge of where the bones lay and the character of the deposits is lost forever, because no records were kept.

The entire site would have been lost forever had it not been for a group of housewives who decided something had to be done. They organized the Mastodon Park Committee and stopped the sale of the land to private developers. They raised half a million dollars to buy the site and transfer title to the Missouri Department of Natural Resources, Division of Parks and Recreation, which developed Mastodon State Park. The old Kimmswick site now has a museum with a grand skeleton of a *Mammut americanum* just like the one in the British Museum.

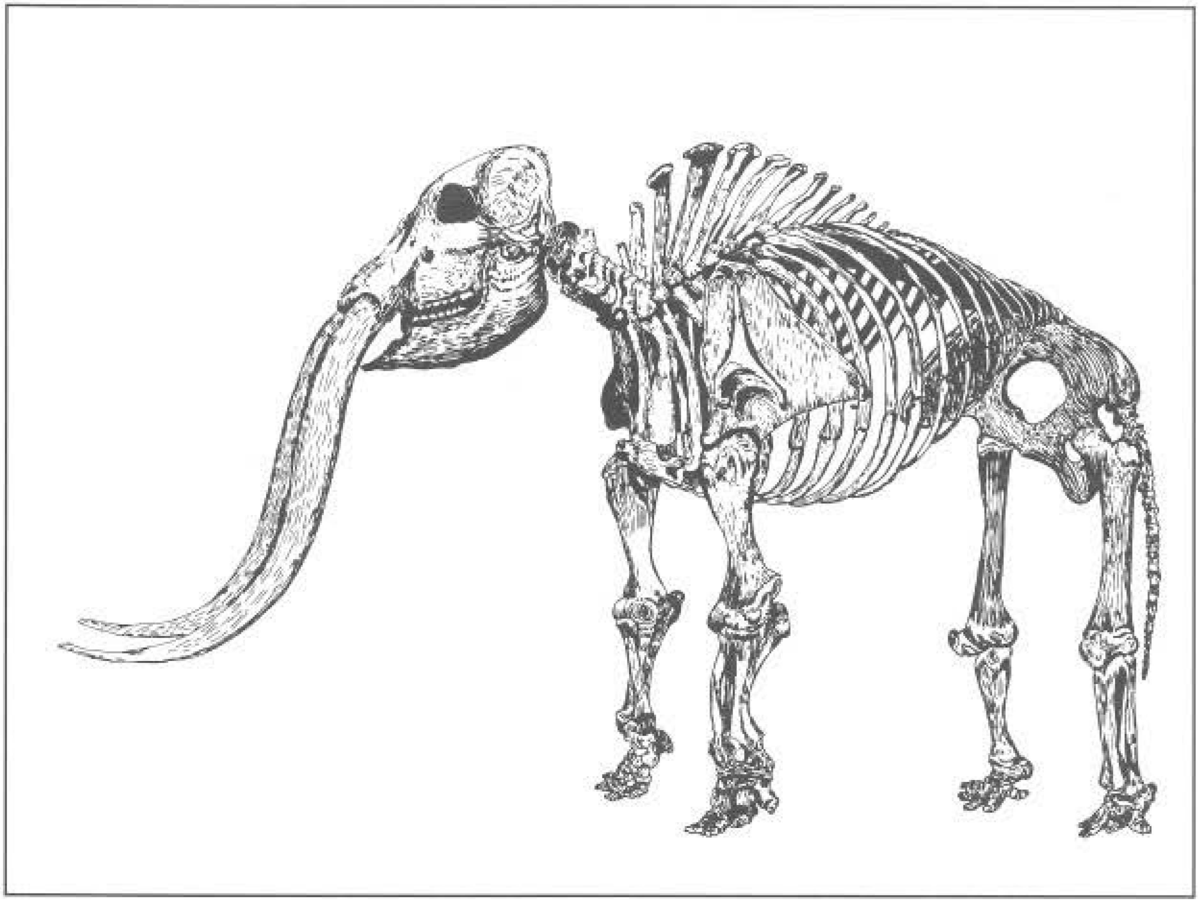


Figure 177

Many bones of some of Missouri's Ice Age animals were discovered by Albrecht Koch at the Kimmswick paleontological site. (Sketch from Missouri's Ice Age Animals *by M.G. Mehl, 1962.)*

388. CROOKED CREEK STRUCTURE

Crawford County, 10 miles south of Steelville and 3 miles northeast of Cook Station on Highway VV, center in SW¼ sec. 17, T. 36 N., R. 4 W., Cook Station 7½-minute Quadrangle.

389. DECATURVILLE STRUCTURE

Camden County, at west edge of Decaturville, on west side of Highway 5, 9 miles south of Camdenton, centered in SW¼ sec. 32, T. 37 N., R. 16 W., Decaturville 7½-minute Quadrangle.

Missouri contains several complex geologic structures of debatable origin, such as the Crooked Creek Structure (fig. 178) and the Decaturville Structure. One school of thought holds that they are the result of explosive activity, probably igneous, at depth. Such an origin is designated as cryptoexplosive (Snyder and Williams et al, 1965) or cryptovolcanic. Another hypothesis is that they are the result of meteorite impacts and thus would be called astroblemes (Hendriks, 1954; Snyder and Williams et al., 1965, p. 68-72). Although small meteorites have been found in Missouri, no meteorite fragments have been discovered at these unusual areas. Those who would hold to the cryptoexplosive hypothesis are likewise short-changed on geologic evidence because no indications of high-temperature alteration of the rocks exist and thus proponents of the two hypotheses are at somewhat of a stalemate.

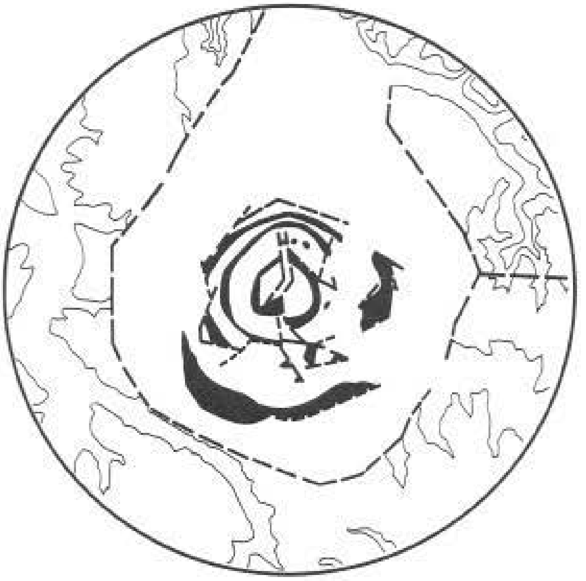


Figure 178

Stylized drawing of the Crooked Creek Structure in Crawford County.

Regardless of the hypothesis for the genesis, there is no doubt that some local catastrophic event took place. In the case of each, rocks are intensely fractured, crushed, and folded in an annular and polygonal pattern with a radius of several miles. These areas are described by Hendriks (1954, p. 52-70) who studied the Crooked Creek area and Snyder and Williams et al. (1965, p. 45-46, 68-71) who described both structures. Both of these sites require serious study and a willingness to do a bit of walking. Earthbound photography in the area is not particularly rewarding, in contrast with air photos which (especially in the case of Crooked Creek) show the annular topographic and vegetation patterns.

The Decaturville Quadrangle shows a "Drill Hole" in the SW¼ sec. 32, and a large, rectangular building (the old ore-milling structure) in NW¼ sec. 5 which were parts of the ill-fated Decaturville Mining Company. Mining activities continued sporadically for several years, in hope that whatever caused the structure would also have emplaced mineable deposits of metals or exotic minerals. All mining efforts failed, and the land is now in pasture; access permission is required.

In straightening Missouri Highway 5 south of the Decaturville structure, the Missouri Department of Highways and Transportation drove a roadcut through part of the structure. The resulting exposure of contorted and tilted strata is a geologist's delight. The cut begins 0.75 mile south of Decaturville, where the old road once veered to the west, but now goes straight south. The north end of the cut exposes steeply dipping rock strata, for 500 feet or so to the south. The rocks show increasing evidence of massive disturbance. At the south end of the cut, highly brecciated rock suggests some cataclysimic event.

Geologists will want to consult the highly detailed map of the Decaturville cryptoexplosive structure by Offield and Pohn (1979), who describe it at length as an extraterrestrial impact structure.

390. DEVILS PROMENADE (THE SPOOKLIGHT)

Newton County, Missouri, 3 miles southwest of Hornet or 4 miles south of Tri-State marker for common corners of Missouri, Oklahoma, and Kansas. Spooklight Museum in NW¼ SW¼ sec. 26, T. 26 N., R. 34 W., Racine, Missouri-Oklahoma-Kansas 7½-minute Quadrangle.

This feature is a mysterious light rather than a proved geologic phenomenon. According to the Harbinger (Anonymous, 1970, p. 3-6), the bobbing ghostly light has been seen on a country road since at least 1886. Does it result from a long distance reflection or refraction of a natural light? Is it luminous marsh gas? "Fox fire" from phosphorescent fungi or decayed vegetation (bioluminescence)? Quien sabe!

Randolph (1964, p. 233-235) who has written a thorough description of this locale says:

> *"I have seen this light myself, on three occasions. It first appeared about the size of an egg but varied until sometimes it looked as big as a washtub. It is hard to judge the distance, but the light seemed about a quarter of a mile off when I first saw it and disappeared when it approached to a distance of perhaps seventy-five yards."*

He summarized theories regarding its origin, stating that, *"Some people think that the light at the Devils Promenade is the ghost of an Osage Chief who was murdered near this spot; others say it is the spirit of a Quapaw maiden who drowned herself in the river when her warrior was killed in battle."* Other theories he presents are those of marsh gas, automobile lights driving east on Highway 66, and Quapaw, Oklahoma airport beacon lights. His concluding statement eliminates sources resulting from modern technology for he says:

"But the old-timers laugh at all such explanations, claiming that the Indian lights were seen at the same spot in the deep wood, fifty years before the 'Devil's Promenade' road was built. Fred C. Reynolds of Kansas City says that his grandfather, a pioneer doctor at Baxter, Kansas, observed these lights long before there was any such thing as a motor car, adding that he himself saw the jack-o-lantern as a boy. Bob Hill of Joplin, Missouri, observes that the phantom was seen by many persons in this vicinity before there was a Highway 66, and certainly long before the airport was established at Quapaw, Oklahoma."

Wood (1977) cites additional legends and has photographs of the light as well as a map of the environs.

From the junction of Highways 43 and BB, 3 miles northwest of Racine, go west for approximately 2.5 miles to a T-junction. From that junction, go north for 1.25 miles to the Spooklight Museum at junction. This junction is on the Oklahoma-Missouri border. To look for the spooklight, look westward from the museum along the east-west Oklahoma road. Mr. Thomas Roth, geology student at UMR, kindly supplied detailed directions for reaching the site.

14

Geographic Tidbits

391. LOWEST POINT IN MISSOURI (ST. FRANCIS RIVER, DUNKLIN COUNTY)

Dunklin County, extreme southwestern corner of the Bootheel, where the St. Francis River enters Arkansas, Leachville 7½-minute Quadrangle.

One would expect the lowest point in Missouri to be at the south tip of the Lowlands, but surprisingly this point is not along the Mississippi but rather, on the St. Francis River. The U.S. Geological Survey (*circa* 1970, p. 7) cites U.S. Coast and Geodetic Survey data for the lowest point, 230 feet above sea level, being on the St. Francis River in Dunklin County, at the extreme southwestern corner of the Bootheel where the St. Francis River enters Arkansas on the Leachville Quadrangle. The extreme southeastern corner of the Bootheel would probably hold this honor were it not for the fact that the Missouri-Tennessee boundary is along a former course of the Mississippi which is now floodplain on the west side of the river and is thus at an elevation slightly higher than the modern St. Francis River bank. Were the center of the present valley of the Mississippi used as a state boundary, the lowest point would be slightly under 235 feet in extreme southeastern Missouri.

392. DEEPEST HIGHWAY CUT IN MISSOURI (BEAR MOUNTAIN CUT)

Taney County, on Highway 65, 8 miles north of Branson, Day 7½-minute Quadrangle.

This cut, more than 150 feet deep, is in dolomites of the Jefferson City-Cotter. It has been benched to minimize the hazards of rock falls and recycling of the Falling Rock "joke" and is also the subject of colored commercial postcards. The deep cuts on I-44 north of Pacific held the previous honor, and they in turn superseded the cut at Hooker, near Devils Elbow, for First Honors.

The center of the 0.3 mile-long cut is 0.8 mile north of the junction with Highway 160 east and 2.0 miles south of the junction with Highway 176 south.

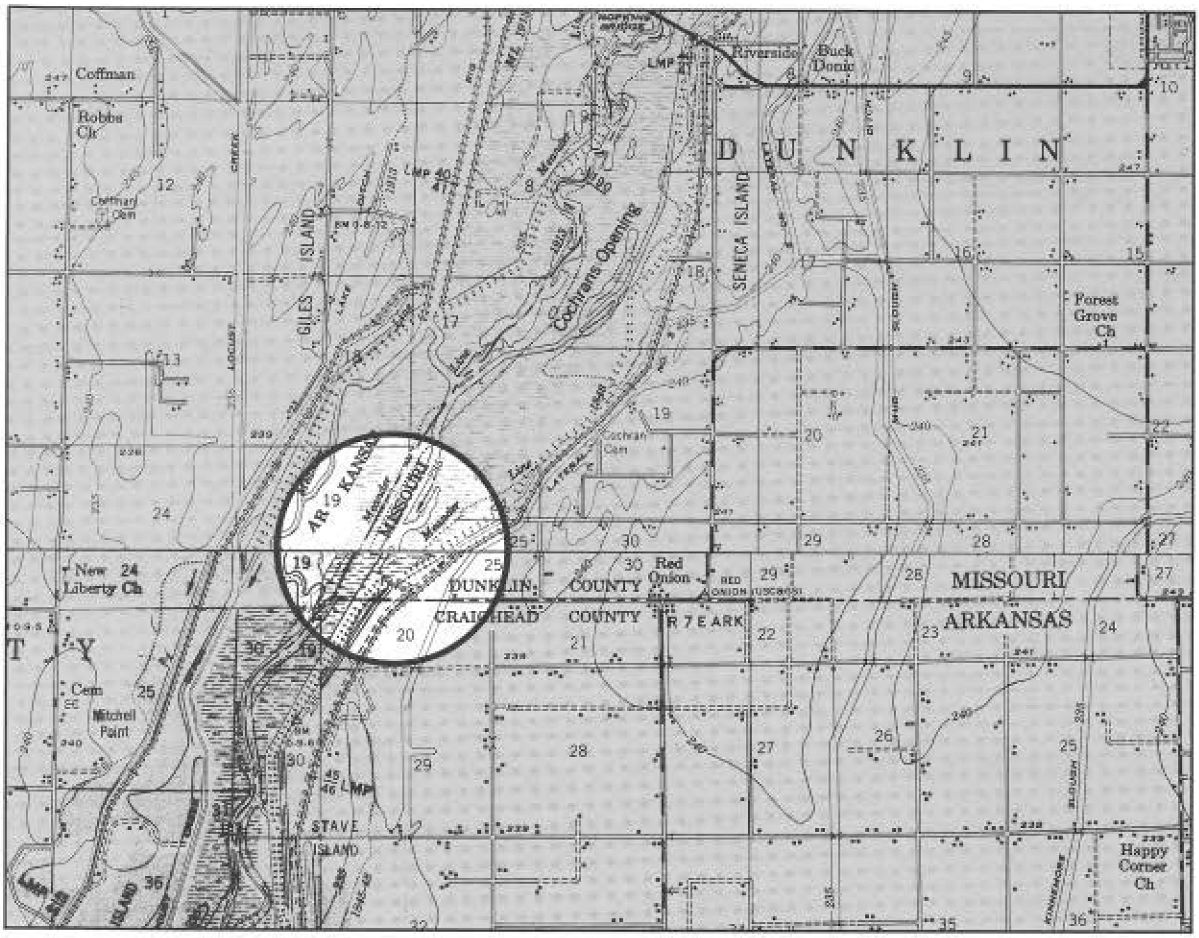

Coffman
Robbs Ch
Coffman Cem
LOCUST CREEK
GILES ISLAND
Cochrans Opening
Riverside
Buck Donic
D U N K L I N
SENECA ISLAND
SLOUGH
Forest Grove Ch
Cochran Cem
New Liberty Ch
ARKANSAS
MISSOURI
Red Onion
DUNKLIN COUNTY
CRAIGHEAD COUNTY
R 7 E ARK
MISSOURI
ARKANSAS
Cem
Mitchell Point
STAVE ISLAND
LMP
KINNEMORE
Happy Corner Ch

Figure 179

The lowest point in Missouri is on the St. Francis River in Dunklin County.

BOUNDARY ANOMALIES

Meanders, natural cut-offs, and artificial cut-offs can result in some interesting geographic anomalies. In at least three places in Missouri, Illinois owns an appreciable amount of land on the right side of the Mississippi River, the right bank always being designated as that on the right looking downstream.

If a stream changes its channel gradually by erosion on one side and deposition on the other, the property owner on the eroded side owns gradually shrinking real estate and the one on the deposition side gains. In contrast, if a stream channel is changed more suddenly, an avulsion may result (fig. 180) as in the cases cited below. Avulsions can be natural or artificial, and are quite common when a stream cuts through a meander loop neck when in flood stage. An avulsion does not change ownership but it may require buying a boat!

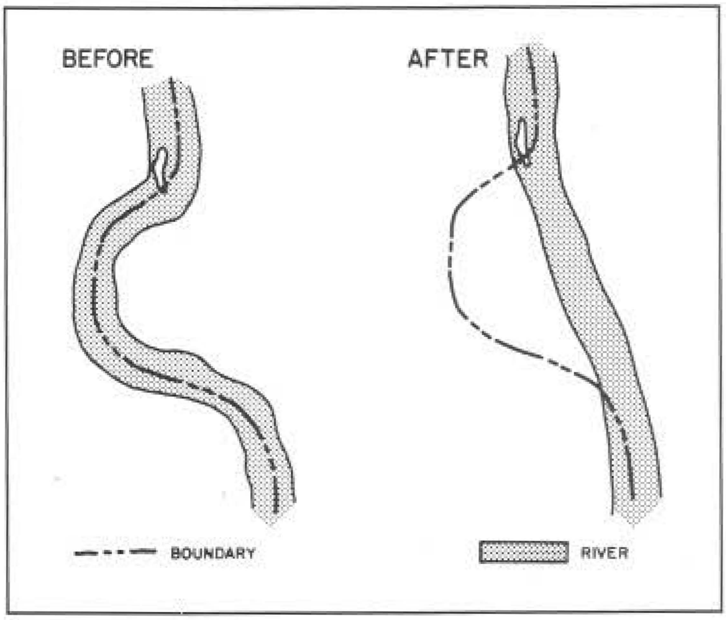


Figure 180

An avulsion may result when a stream channel changes suddenly. Example from U.S. Geological Survey, Wickliffe SW, Missouri-Kentucky, 7½-minute Quadrangle, Missouri-Kentucky boundary along the Mississippi River.

393. KASKASKIA AVULSION

Between Chester, Illinois, and St. Marys, Missouri, an area of Illinois some 5 miles in diameter now lies on the southeastern or right side of the Mississippi River. It contains the town of Kaskaskia and is in Illinois because the original boundary was established at the time the main channel was against the west bluff at the Ste. Genevieve-Perry County line, Missouri. Franzwa (1973, p. 149-151) describes the channel change as taking place in 1881.

394. CROSNO AVULSION
395. WOLF ISLAND NO. 5 AVULSION

Two portions of Kentucky are on the west side of the channel as indentations into Mississippi County, Missouri, southeast of Charleston.

396. GRAND TOWER ISLAND AVULSION

Missouri owns land on the east side of the present-day Mississippi channel in southeastern Perry County at Grand Tower Island, south of the Illinois town of Grand Tower (fig. 181).

397. MADRID BEND MEANDER LOOP

South of New Madrid, Missouri, Kentuckians are isolated by a huge meander loop, rather than a channel change and must (or may) cross part of Tennessee to enter their home state to the east by land (fig. 182).

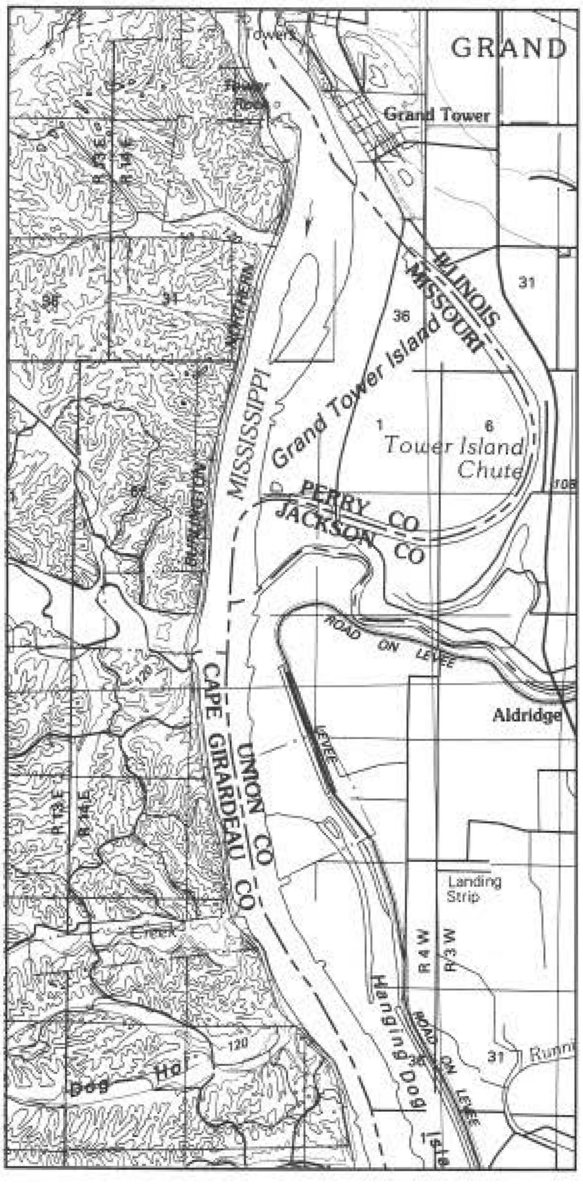

GRAND
Grand Tower
Tower Rock
ILLINOIS
MISSOURI
31
36
Grand Tower Island
1
6
Tower Island Chute
PERRY CO
JACKSON CO
MISSISSIPPI
ROAD ON LEVEE
Aldridge
LEVEE
UNION CO
CAPE GIRARDEAU CO
Landing Strip
R 4 W
R 3 W
Hanging Dog
Creek
120
Dog Hol
31
36

Figure 181

Grand Tower Island is no longer an island, but it was when the border between Missouri and Illinois was surveyed in the early 1800's so it remains a part of Missouri even though the river has changed its course. Map by the U.S. Geological Survey, 1:100,000 scale series, Carbondale, Illinois-Missouri Quadrangle, 1986.

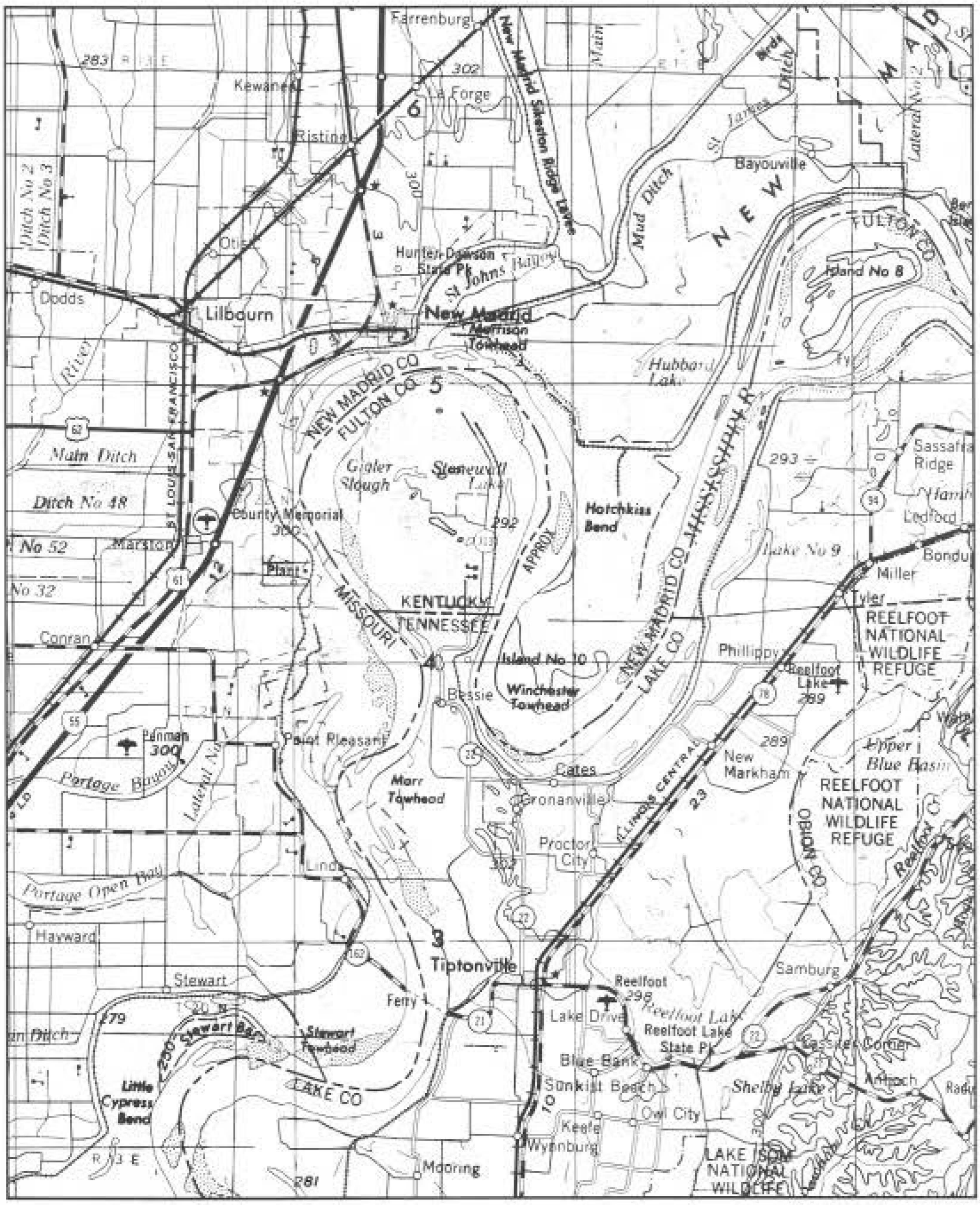

Farrenburg
Kewanee
La Forge
Risting
Otis
Dodds
Lilbourn
Hunter-Dawson State Pk
St Johns Bayou
New Madrid
Morrison Towhead
Bayouville
Mud Ditch
St James Ditch
NEW MAD
FULTON CO
Island No 8
Hubbard Lake
NEW MADRID CO
FULTON CO
Gigler Slough
Stonewall Lake
Hotchkiss Bend
MISSISSIPPI R
Main Ditch
Ditch No 48
County Memorial
Marston
No 52
No 32
Conran
MISSOURI
KENTUCKY
TENNESSEE
APPROX
Island No 10
NEW MADRID CO
LAKE CO
Winchester Towhead
Bessie
Phillippy
Reelfoot Lake
Sassafras Ridge
Lake No 9
Miller
Tyler
Bondurant
REELFOOT NATIONAL WILDLIFE REFUGE
Penman
Portage Bayou
Lateral No
Point Pleasant
Marr Towhead
Cates
Cronanville
ILLINOIS CENTRAL
New Markham
Upper Blue Basin
REELFOOT NATIONAL WILDLIFE REFUGE
OBION CO
Proctor City
Linda
Portage Open Bay
Hayward
Stewart
Tiptonville
Ferry
Samburg
Reelfoot
Reelfoot Lake
Reelfoot Lake State Pk
Lake Drive
Stewart Bars
Stewart Towhead
Little Cypress Bend
LAKE CO
Blue Bank
Sunkist Beach
Shelby Lake
Owl City
Keefe
Wynnburg
Mooring
LAKE ISOM NATIONAL WILDLIFE
Lassiter Corner
Antioch
Ditch No 2
Ditch No 3
ST LOUIS SAN FRANCISCO
New Madrid Sikeston Ridge Levee

Figure 182

The great meander loop of the Mississippi River known as Madrid Bend isolates some Kentuckians from the rest of their state. Should the Mississippi ever cut through the narrow neck of the loop at Bessie, Tennessee, part of Kentucky would then be in Missouri. Map by the U.S. Geological Survey, 1:250,000 scale series, Dyersburg, Tennessee-Kentucky-Missouri-Illinois, 1956.

PIGS IN POKES

The following sites were not visited but have intriguing names on topographic quadrangle maps.

398. POTHOLE HOLLOW

Ripley County, 4 miles southeast of Grandin, in center N½ sec. 31, T. 25 N., R. 3 E., Grandin 7½-minute Quadrangle.

Time and high water precluded a hike to this tributary on the north side of North Prong Little Black River. It could be reached via Highway NN southeast of Grandin with some hiking and stream fording. Does it contain potholes carved by swirling stream waters charged with abrasive sand?

399. STANDING ROCK HOLLOW

Shannon County, 6 miles northeast of Summersville, drains northeast, entering Black Valley Creek, in SE¼ sec. 34, T. 30 N., R. 6 W., Summersville NE 7½-minute Quadrangle.

Why is this hollow so-named? Does it contain an isolated pinnacle or chimney similar to other namesakes in the Ozarks?

400. FALLS HOLLOW

Dent County, in secs. 28 and 29, T. 32 N., R. 7 W., 2 miles southwest of Montauk Springs, named on Montauk 7½-minute Quadrangle.

Are there waterfalls here?

The topographic maps shows a normal gradient from the head of the hollow, on a ridge, to the mouth of the hollow, on Pigeon Creek.

401. TUNNEL BLUFF

Dade County, on southwest side of Little Sac River, 1.5 miles northeast of Bona, Bona 7½-minute Quadrangle.

Opening the poke showed this to be a fooler. It is designated as Tunnel Bluff on the Bona 7½-minute Quadrangle. Local inquiry revealed that the bluff is named after a family rather than a natural or artificial tunnel.

402. MILL ROCK

Franklin County, 5 miles south of Gerald, on north side of Bourbeuse River, at Mill Rock Ford, in SE¼ SE¼ SW¼ sec. 31, T. 42 N., R. 3 W., Strain 7½-minute Quadrangle.

This is a last-minute addition which was not visited. Renken (1977b, p. 5B) describes the site as follows:

"Mill Rock, on the north side of the river at Mill Rock Ford, is a strange formation carved by the river and a tributary creek. The rock, 30 or so feet high, has growing out of its perfectly flat top a single Cedar tree. Just where the name Mill Rock comes from is unclear, but it has all sorts of possibilities for would-be legend makers.

"Incidentally, Mill Rock Ford and the rock garden below it pose some interesting navigation problems in all but flush water conditions."

A state highway map and the Strain Quadrangle would be appropriate navigational aids for those unfamiliar with the area.

15

The Devil in Missouri

The preoccupation of pioneer Missourians with the Devil is dramatized by the dozens of natural features considered to be creations, haunts, or even corporeal (e.g. elbow, backbone) parts of the Devil. Settlers from the Appalachian highlands were largely Scotch-Irish in their background and their concern with the Devil was undoubtedly, in many cases, a result of Calvinistic influences rather than familiarity with the legend of Faust. No cases of natural surface features involving angels were found. This condition is in sharp contrast to the western United States where the Latin-American influence predominated and features incorporating terms alluding to angels and heaven are common.

Biblical influences are demonstrated by Ramsay, who in his captivating discussion of Missouri place names says (1952, p. 101):

"Almost all of the familiar spots of the Holy Land have been transplanted to Missouri soil. The Hebrews of the Old Testament described the whole compass of their country as stretching 'from Dan to Beersheba.' Here in Missouri one can travel from Dan in Maries County to Beersheba only a few miles away in Montgomery. We can follow the steps of Abraham of the Gospels and the missionary journeys of Paul on our Missouri map without missing a single one of them."

He further states (p. 112):

"A large portion of the territory of Missouri, however, is still recognized as the property of the Devil, if place names are sufficient evidence of ownership. More than 30 localities attest the healthy respect we have for his Satanic Majesty."

The following list of more than 80 such natural features has been compiled from personal knowledge, published material, topographic maps, and information supplied by the staff of the Missouri Department of Natural Resources, Division of Geology and Land Survey. It is undoubtedly not complete. Although 25 Devils Backbones are listed, some probably failed to make the honor roll because they are not named on topographic maps. The nine Devils Dens cited are probably insufficient to house this omnipresent chap.

DEVILISH HAUNTS IN MISSOURI

No. and Name	Location	Feature Type	Remarks
403. DEVILS ARMCHAIR (DEVILS CHAIR-BACK)	Morgan County, north-facing bluff on Ivy Bend, in SW¼ NE¼ sec. 26, T. 40 N., R. 19 W.	Pinnacles bluff	Twin pinnacles separated by a saddle produce profile like upper chair-back (looking south). Courtesy Neil Heimsoth, Rolla. Bollinger Creek 7½-minute Quadrangle.
404. DEVILS BACKBONE	Benton County, sec. 2, T. 40 N., R. 23 W.	Ridge	Named on Shawnee Bend 7½-minute Quadrangle.
162. DEVILS BACKBONE	Boone County	Ridge	Described on page 118.
39. DEVILS BACKBONE	Buchanan County	Ridge	Described on page 37.
163. DEVILS BACKBONE	Callaway County	Ridge	Described on page 119.
405. DEVILS BACKBONE	Camden County, sec. 12, T. 37 N., R. 17 W., sec. 7, T. 37 N., R. 16 W.	Ridge	Named on Decaturville 7½-minute Quadrangle.
406. DEVILS BACKBONE	Cape Girardeau County, N½ sec. 15 (projected), T. 32 N., R. 11 E.	Ridge	On Caney Fork, 2 miles north-northwest of Millersville. Named on Millersville 7½-minute Quadrangle.
407. DEVILS BACKBONE	Douglas County, secs. 17 and 18, T. 25 N., R. 14 W.	Ridge	Named on Wasola 7½-minute Quadrangle.
408. DEVILS BACKBONE	Douglas County, NE¼ sec. 8, T. 25 N., R. 14 W.	Ridge	Named on Rockbridge 7½-minute Quadrangle.
409. DEVILS BACKBONE	Jackson County, secs. 23 and 26, T. 48 N., R. 32 W.	Ridge	On south side of Highway 50 north of Bannister Road and east of Little Blue River. Lees Summit 7½-minute Quadrangle.

No. and Name	Location	Feature Type	Remarks
410. DEVILS BACKBONE	Lincoln County, common corners secs. 4, 5, 8, and 9, T. 51 N., R. 2 W.	Ridge	Not named on Louisville 7½-minute Quadrangle. Per one local resident, rattlesnakes make their debut here on May 2 or 3.
411. DEVILS BACKBONE	Montgomery County, common corners secs. 13 and 19, T. 50 N., R. 4 and 3 W., respectively.	Ridge	Named 'Backbone' on Bellflower North 7½-minute Quadrangle.
412. DEVILS BACKBONE	Morgan County, secs. 27, 28, and 34, T. 42 N., R. 18 W.	Ridge	Named on Proctor Creek and Stover 7½-minute Quadrangles.
413. DEVILS BACKBONE	Morgan County, south-central part sec. 28 and north-central part sec. 33, T. 44 N., R. 18 W.	Ridge	Not named on Florence 7½-minute Quadrangle, but partly included in Devils Backbone Ranch, 9 miles northwest of Versailles.
414. DEVILS BACKBONE	Oregon County, secs. 9 and 16, T. 25 N., R. 4 W.	Ridge	Named on Piedmont Hollow 7½-minute Quadrangle.
415. DEVILS BACKBONE	Oregon County, secs. 14 and 15, T. 24 N., R. 3 W.	Ridge	Named on Many Springs 7½-minute Quadrangle.
416. DEVILS BACKBONE	Ozark County, secs. 23 and 26, T. 24 N., R. 11 W	Ridge	Named on Cureall 7½-minute Quadrangle.
417. DEVILS BACKBONE	Perry County, sec. 18, T. 35 N., R. 13 E.	Ridge	Not named on Crosstown 7½-minute Quadrangle.
418. DEVILS BACKBONE	Phelps County, sec. 31, T. 38 N., R. 9 W.	Ridge	Named on Newburg 7½-minute Quadrangle.
164. DEVILS BACKBONE	Pulaski County	Ridge	Described on page 119.
419. DEVILS BACKBONE	Ripley County, sec. 5, T. 24 N., R. 3 E.	Ridge	Named on Grandin 7½-minute Quadrangle.

No. and Name	Location	Feature Type	Remarks
38. DEVILS BACKBONE	Saline County, Van Meter State Park.	Ridge	Described on page 36.
420. DEVILS BACKBONE	Shannon County, neck between loops of Spring Valley, 1.2 miles south of north line, sec. 5, T. 29 N., R. 5 W.	Ridge	Not named on Summersville NE 7½-minute Quadrangle.
421. DEVILS BACKBONE	Shannon County, W½ sec. 36 and NE¼ SE¼ sec. 35, T. 28 N., R. 6 W.	Ridge	Southeast side of Jacks Fork and northeast side of Johnny Hollow, Jam Up Cave 7½-minute Quadrangle.
151. DEVILS BACKBONE AND NARROWS (AKERS)	Shannon County	Ridge	Described on page 112. See fig. 183.
422. DEVILS BACKBONE	Texas County, at Horseshoe Bend on Big Piney, in SE¼ sec. 25, T. 31 N., R. 10 W., 3 miles northwest of Houston.	Ridge	Not named on Houston 7½-minute Quadrangle.
347. DEVILS BAKE OVEN (DEVILS FRETWORK)	Ste. Genevieve County	Rock arch and pinnacle	Described on page 294, in Chimney Rocks area.
423. DEVILS BOOT	Warren County	Cave	Location details in Division of Geology and Land Survey files.
424. DEVILS CAVE	Howell County	Cave	Location details in Division of Geology and Land Survey files.
425. DEVILS CHUTE	Near Dallas-Laclede County line on Niangua River, 2.5 miles downstream from Bennett Spring Branch.	Fast water chute	Described by Renkin (1977a, p. 4B), reportedly S-shaped, 200 yards long.
376. DEVILS COURTYARD	Buchanan County	Fractured limestone	Described on page 318.

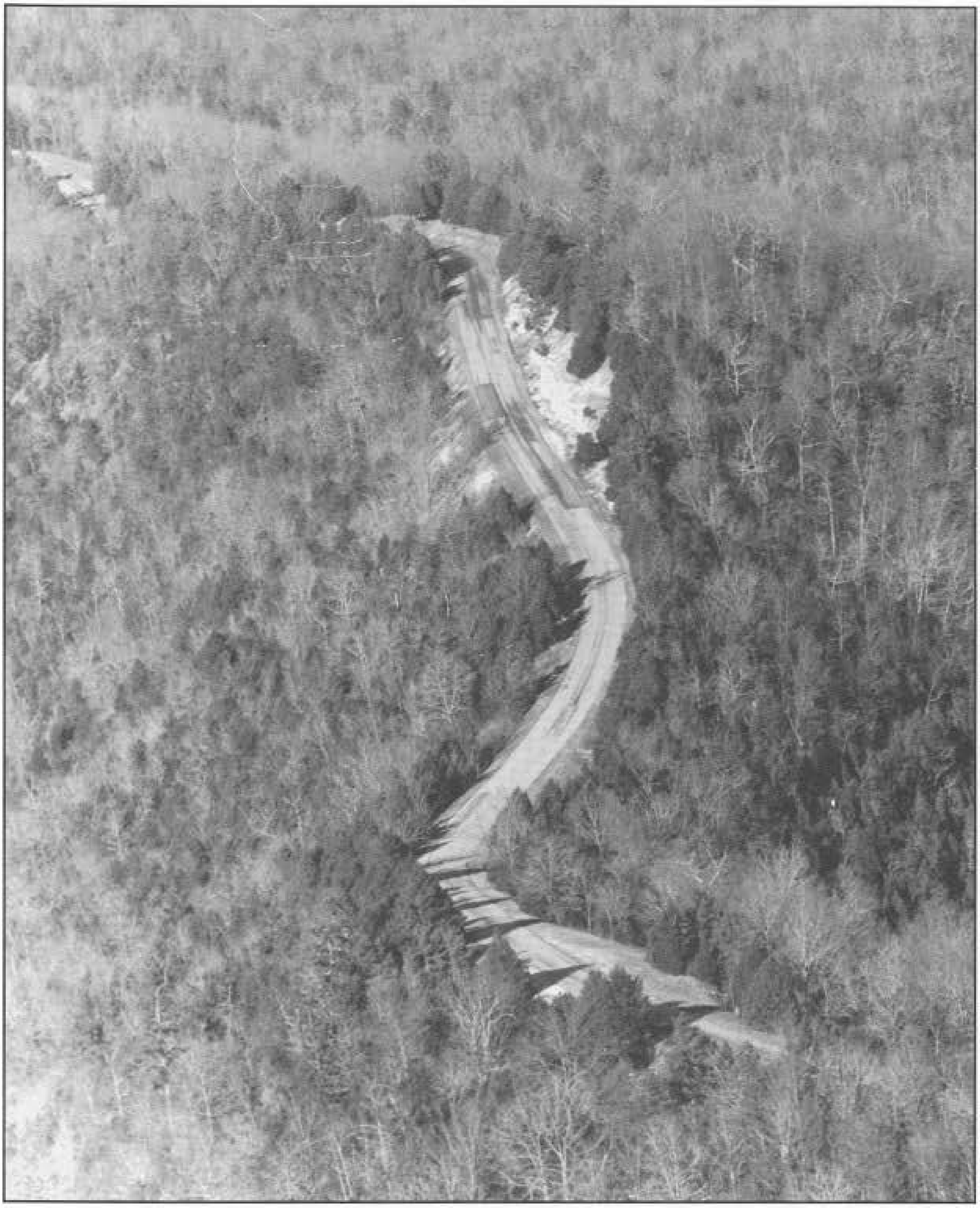


Figure 183

The Devils Backbone on Highway K at Akers, Shannon County, is the narrowest ridge used for a Missouri State Highway. Photo by Jerry D. Vineyard and James H. Williams.

No. and Name	Location	Feature Type	Remarks
426. DEVILS DEN	Howell County, SE¼ sec. 11, T. 22 N., R. 8 W.	Sinkhole	Named on Lanton 7½-minute Quadrangle.
204. DEVILS DEN	Shannon County	Sinkhole	Described on page 162, in The Sunkland.
427. DEVILS DEN	Stone County	Cave	Former name of Marvel Cave.
99. DEVILS DEN	Taney County	Pinnacled stream valley	Described on page 68.
209. DEVILS DEN	Webster County	Sinkhole	Described on page 169.
428. DEVILS DEN HOLLOW	Iron County, sec. 11, T. T. 33 N., R. 4 E.	Stream valley	Named on Lake Killarney 7½-minute Quadrangle.
429. DEVILS DEN HOLLOW	Ste. Genevieve County, NW¼ sec. 8 and SW¼ SW¼ sec. 5, T. 35 N., R. 9 E., on east side of Brushy Creek.	Steep hollow	Named on Minnith 7½-minute Quadrangle.
430. DEVILS DEN HOLLOW	Stone County, secs. 20, 21, and 28, T. 23 N., R. 23 W.	Stream valley	Named on Reeds Spring 7½-minute Quadrangle.
100. DEVILS DEN HOLLOW	Warren County	Waterfalls	Described on page 70.
352. DEVILS DINING TABLE	Miller County	Capped pinnacle	Described on page 300.
455. DEVILS ELBOW	Pulaski County	Sharp riverbend (also town name)	Described on page 347.
431. DEVILS ELBOW	Butler County		Exact location unknown. See Ramsay, 1952, p. p. 114.
347. DEVILS FRETWORK (DEVILS BAKE OVEN)	Ste. Genevieve County	Eroded sandstone	Described on page 293, in Chimney Rocks area.

No. and Name	Location	Feature Type	Remarks
432. DEVILS HOLE	Barry County	Sinkhole cave	Location details in Division of Geology and Land Survey files.
433. DEVILS HOLE	Laclede County	Sinkhole cave	Location details in Division of Geology and Land Survey files.
434. DEVILS HOLE CAVE	Shannon County	Sinkhole cave	Location details in Division of Geology and Land Survey files.
435. DEVILS HOLLOW	Bates County, NW¼ NW¼ NE¼ and SE¼ NE¼ NW¼ sec. 35, T. 40 N., R. 31 W.	Cavernous sandstone bluff	South side of Mound Branch (Musser, 1975); Butler and Vicinity 7½-minute Quadrangle.
436. DEVILS HOLLOW	Texas County, 2-3 miles west of Raymondville	Stream valley	Named on Raymondville 7½-minute Quadrangle.
10. DEVILS HONEYCOMB	Washington County	Columnar porphyry	Described on page 18.
437. DEVILS HORN	Carter County, sec. 9, T. 25 N., R. 1 W.	Stream valley	Named on Handy 7½-minute Quadrangle.
438. DEVILS HORN	Worth County, center W½ sec. 7, T. 66 N., R. 32 W.	Mound	Named on Sheridan, Iowa-Missouri 7½-minute Quadrangle.
289. DEVILS ICEBOX	Boone County	Sinkhole	Described on page 236, in Rock Bridge Memorial State Park.
439. DEVILS ICEBOX	Iron County, on west side Pilot Knob near crest, in NW¼ NW¼ NE¼ SW¼ sec. 29, T. 34 N., R. 4 E.	"Canyon" and "Cave" collapsed mine workings)	Reported to be very cool in summer, yet required sweat-producing climb. Ironton 7½-minute Quadrangle.
221. DEVILS KETTLE	Bollinger County	Sinkhole	Described on page 178.
440. DEVILS KITCHEN	Barry County, above Roaring River Spring	Tumbled blocks of limestone	Described by Beckman and Hinchey (1944, p. 109).

No. and Name	Location	Feature Type	Remarks
323. DEVILS KITCHEN (DEVILS FIREPLACE)	Camden County	Slotted cave	Described on page 267.
441. DEVILS KITCHEN	Carter County, sec. 7, T. 27 N., R. 3 E.	Mine	Named on Ellington SE 7½-minute Quadrangle.
442. DEVILS POOL	Taney County, NE¼ SW¼ sec. 12, T. 21 N., R. 22 W.	Spring	Named on Table Rock Dam 7½-minute Quadrange. Described on p. 322.
339. DEVILS PROMENADE	Camden County	Sinkhole rim	In Hahatonka area, page 282. See fig. 148.
390. DEVILS PROMENADE (THE SPOOKLIGHT)	Newton County	Area of mysterious phantom light	Described on page 329.
248. DEVILS PUNCH BOWL	Phelps County, northeast corner sec. 36, T. 36 N., R. 9 W.	Sink structure	Described on page 198.
443. DEVILS RACEGROUND	Franklin County, in Missouri River, above the mouth of Tavern Creek near St. Albans	Whirlpool	See Lewis & Clark Journals (Thwaites, 1904, p. 27).
444. DEVILS RACETRACK	Christian County, at Linden. Approximately 330 yards upstream from Highway 125 on north side of Finley Creek.	Limestone fissures	Maze of vertical joint-controlled fissures in limestone.
445. DEVILS RIDGE	Cass County, E½ sec. 16, T. 46 N., R. 29 W.	Ridge	Named on Strasburg 7½-minute Quadrangle.
446. DEVILS ROCKPILE	Douglas County, sec. 20, T. 25 N., R. 12 W.	Rocky hill	Named on Gentryville 7½-minute Quadrangle. Not particularly unusual.
447. DEVILS RUN	Carter County, secs. 3 and 4, T. 25 N., R. 1 W.	Stream valley (shut-in)	Named on Handy 7½-minute Quadrangle.

No. and Name	Location	Feature Type	Remarks
448. DEVILS RUN	Carter County, secs. 7 and 8, T. 27 N., R. 3 E.	Stream valley	Named on Ellington 7½-minute Quadrangle.
456. DEVILS SUGAR BOWL	Pulaski County, at Devils Elbow	Promontory in bluff	Described on page 347.
270. DEVILS TABLES NATURAL ARCHES	Laclede County	Capped promontory	Described on page 218.
449. DEVILS TEA TABLE	Cape Girardeau County, center NE¼ SW¼ sec. 3, T. 32 N., R. 14 E.	Capped promontory	Partly destroyed by railroad construction (Shoemaker, 1934, p. 134). Ware 7½-minute Quadrangle.
350. DEVILS TEA TABLE	Clark County	Flat-topped ledge in riverbank	Described on page 297.
454. DEVILS TEA TABLE	Pulaski County	Rock promontory	Described on page 347.
351. DEVILS TEA TABLES	Taney County	Pinnacled bluff crest	Described on page 299.
5. DEVILS TOLL GATE	Iron County	Rock fissure	Described on page 9.
167. DEVILS TOWER (TOWER ROCK)	Perry County	Erosional remnant island	Now called Tower Rock, described on page 124.
6. DEVILS WALL	Iron County	Pinnacles and natural wall	Described on page 11.
450. DEVILS WASHBASIN	Warren County		Ramsay, 1952, p. 114.
451. DEVILS WASHBOARD	Dunklin County		Ramsay, 1952, p. 114.
452. DEVILS WASHBOARD	Wayne County		Ramsay, 1952, p. 114.

No. and Name	Location	Feature Type	Remarks
210. DEVILS WASH PAN	Lawrence County, NE¼ SE¼ SE¼ sec. 35, T. 29 N., R. 26 W.	Sinkhole and springs	Described on page 171.
213. DEVILS WELL	Shannon County	Sinkhole	Described on page 173.
214. DEVILS WELL (DEVILS HOLE)	Shannon County	Sinkhole	Described on page 175.
453. RED DEVIL DITCH	Dunklin County	Drainage ditch	Named on Cardwell 7½-minute Quadrangle.

Why is the Devil acknowledged at one locale and not in another? Two Devils Elbows are cited, yet Elbow Creek in Taney County on the Protem 7½-minute Quadrangle escaped the honor. A sharp ridge in Ozark County (W½ sec. 1, T. 24 N., R. 13 W., Gentryville 7½-minute Quadrangle) is simply Backbone Ridge and a tight bend on the Current River suffers the plebeian name of Pigs Ankle. On the same quadrangle, the Devils Rock Pile and Abrahams Knob have been compatible neighbors for thousands of years despite theological differences. A similar coexistence is exemplified in Douglas County southeast of Topaz where Mt. Ararat Church is only a mile removed from Hell Hole Hollow. A rural schoolhouse may even have sold its soul to Mephistopheles; Ramsay (1952, p. 110) refers to a Devils Hall School!

DEVILS ELBOW TERRITORY DRIVE

Pulaski County, near I-44 and Big Piney River, 10 miles east of Waynesville, in secs. 8, 9, 17, and 18, T. 36 N., R. 10 W., Devils Elbow 7½-minute Quadrangle.

(Note: This description was made before U.S. Highway 66 was brought up to interstate standards, thus routing will change).

This drive follows a large S in old Highway 66 through which the newer four-laned I-44 cuts to make a huge dollar sign. The old highway offers an excellent view of sheer bluffs of Gasconade Dolomite capped by the Roubidoux Formation. Building of the present highway required the then-major task of making the Hooker Cut through the Gasconade Dolomite. The newest routing of I-44 passes to the north of the Hooker cuts, offering an even better view of the sheer bluffs along the Big Piney River.

454. DEVILS TEA TABLE

Driving east on Highway 66, turn right onto Highway V, 1.0 mile east of the junction with Highway 28. Shortly after the turnoff, note the Devils Tea Table, a dolomite promontory jutting out of the bluff on the opposite bluff of the Big Piney on right. This was probably formed by erosion controlled by vertical right-angled joints which left a prismatic block remaining as the sole remnant of a former bluff line.

455. DEVILS ELBOW

Devils Elbow is so named because of the sharp bend in Big Piney which was a nemesis to log rafters attempting to round the hairpin curve. Logs and ties were rafted down the Piney until the early-1900's and the industry produced a colorful breed of tie rafters noted for their skill, strength, ability to consume whiskey and fight, and in some cases, knowledge of the Bible.

456. DEVILS SUGAR BOWL

Descend toward the town of Devils Elbow facing bluffs of Gasconade Dolomite which climb more than 200 feet vertically from the river's edge. Weathering and jointing have produced the Devils Sugar Bowl, a huge semicylinder standing vertically with a conical "lid."

Follow Highway V across the four-lane highway and continue on the old concrete road. Stop 0.5 mile after crossing the highway and look to the left to see an excellent example of the relationship between trees and rock type. The Gasconade Dolomite, which forms the typical steep bluffs and is the favorite host for the many caves and springs in Phelps and Pulaski Counties, is capped by cedars (junipers). Cedars are particularly common on dolomite and limestone, and their presence can often be diagnostic to the geologist mapping rock formations.

Sandstones of the Roubidoux Formation overlie the Gasconade Dolomite and the contact of the two formations is marked by a sharp topographic break as cedar-capped Gasconade bluffs are topped by pine-covered gentle slopes on the acid soil formed by weathering of the Roubidoux sandstones.

The Roubidoux Formation is at the surface over large areas in the drainage basins of both Big and Little Piney Rivers in Pulaski, Phelps, and Texas Counties. As a result this area was in the past a major source of pine and the streams were given appropriate names.

Along this route the topography is typical of that formed in entrenched stream meanders. Steep bluffs are developed where erosion is most active on the concave side of river bends as centrifugal force causes the stream to impinge on the bedrock. Bluffs in the Gasconade Dolomite are especially steep because the formation tends to have thick beds and many vertical joints. As a result, huge blocks of dolomite break away from the bluff and fall into the stream, leaving vertical faces where they once were, and creating fish shelters in the streams. Continue this route for 0.5 mile to its junction with Highway 66.

If driving west from Rolla, trace this route in reverse by turning off Highway 66 at the Hooker Community, 7.0 miles west of the Little Piney bridge or 1.9 miles west of the junction with Highway J. A westbound traveler could follow the route as described in this log by turning off Highway 66 onto Highway V, 1.0 mile west of the Big Piney bridge.

457. DEVILS KITCHEN (JDV)

Barry County, 7 miles south of Cassville, in Roaring River State Park, on the Devils Kitchen Trail, in NE¼ NW¼ SW¼ SE¼ sec. 27, T. 22 N., R. 27 W., Eagle Rock 7½-minute Quadrangle.

Despite being in a state park, on a marked trail, and in view of a paved highway, both Beveridge and Vineyard missed Devils Kitchen, and it did not appear in the first edition of *Geologic Wonders and Curiosities of Missouri.* Nevertheless, it is well worth a visit, and the short hike through a forest of stately cedars to the Kitchen is a pleasant interlude.

Devils Kitchen Trail has two trailheads: one at the junction of Highway 112 and the road to Roaring River Spring, and the other about a half mile up the road toward the spring. As the crow flies, the Kitchen is just a few hundred yards from Highway 112 intersection, up the nose of a north-trending ridge.

Devils Kitchen is a rock-bound room formed by large subsidence blocks of Mississippian limestone in such juxtaposition that they define a room about 35 feet long, 4 to 6 feet wide at the entrance, and high enough to walk through. At the rear there is a small "back door" formed by shifting of the rock masses along joint planes.

If the Devil built this "kitchen," his lack of craftsmanship shows. No corners are square, and though the walls are straight, they are not vertical. But it *could* serve as a kitchen of sorts, because the ceiling slopes upward toward the back of the room, where the natural draft would carry smoke and cooking odors upward and outward. Some of the gaps between massive rock walls could have served as a bake oven, but there is no evidence that Devils Food Cake was ever prepared here.

The origin of the Devils Kitchen is easier to decipher if one understands the local geology. From the parking area at the trailhead, the path leads up a rocky hill with rough "steps" defined by ledges of tan dolomite, the Ordovician Cotter Dolomite. In places, the natural steps were improved with concrete, by Civilian Conservation Corps boys in the early days of the park.

Where the trail reaches a relatively level bench about halfway up the hill, it swings west toward the Kitchen. This "bench" is a natural product of the weathering of the less massive, less resistant Mississippian formation above the Cotter. Along the trail, a few hundred feet beyond the Kitchen, a small spring flows from a cave opening beside the trail. The roof of this cave is the Mississippian Compton Limestone; the walls are formed in the sandstone and shale of a thin unit known as the Bachelor Formation. Imagine this thin, easily eroded Bachelor unit beneath the Kitchen area, and you can understand how its erosion could cause the overlying rock masses to shift and slide, eventually forming the Devils Kitchen as a fortuitous freak of nature. Indeed, all along the trail from the Kitchen to the small spring one can see undermining of the cliffrocks and their breakage along fracture planes.

The Missouri Department of Natural Resources, Division of Parks, Recreation, and Historic Preservation distributes a well-illustrated self-guiding brochure for the Devils Kitchen Trail. Detailed line drawings (figs. 184 and 185 are from the brochure) explain the natural history of the area and the relationship between the geology and the biological elements of the landscape.

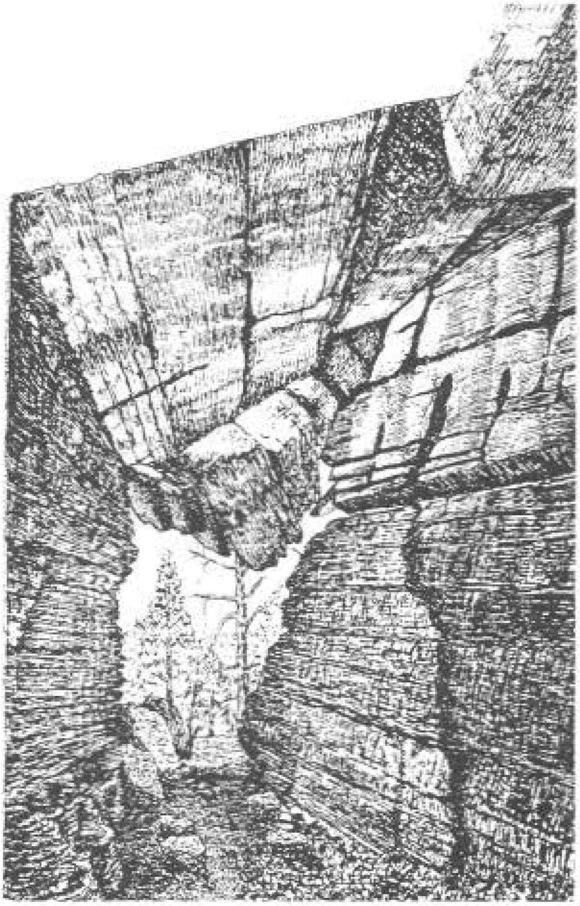


Figure 184

Devils Kitchen. Illustration by Dickson Stauffer.

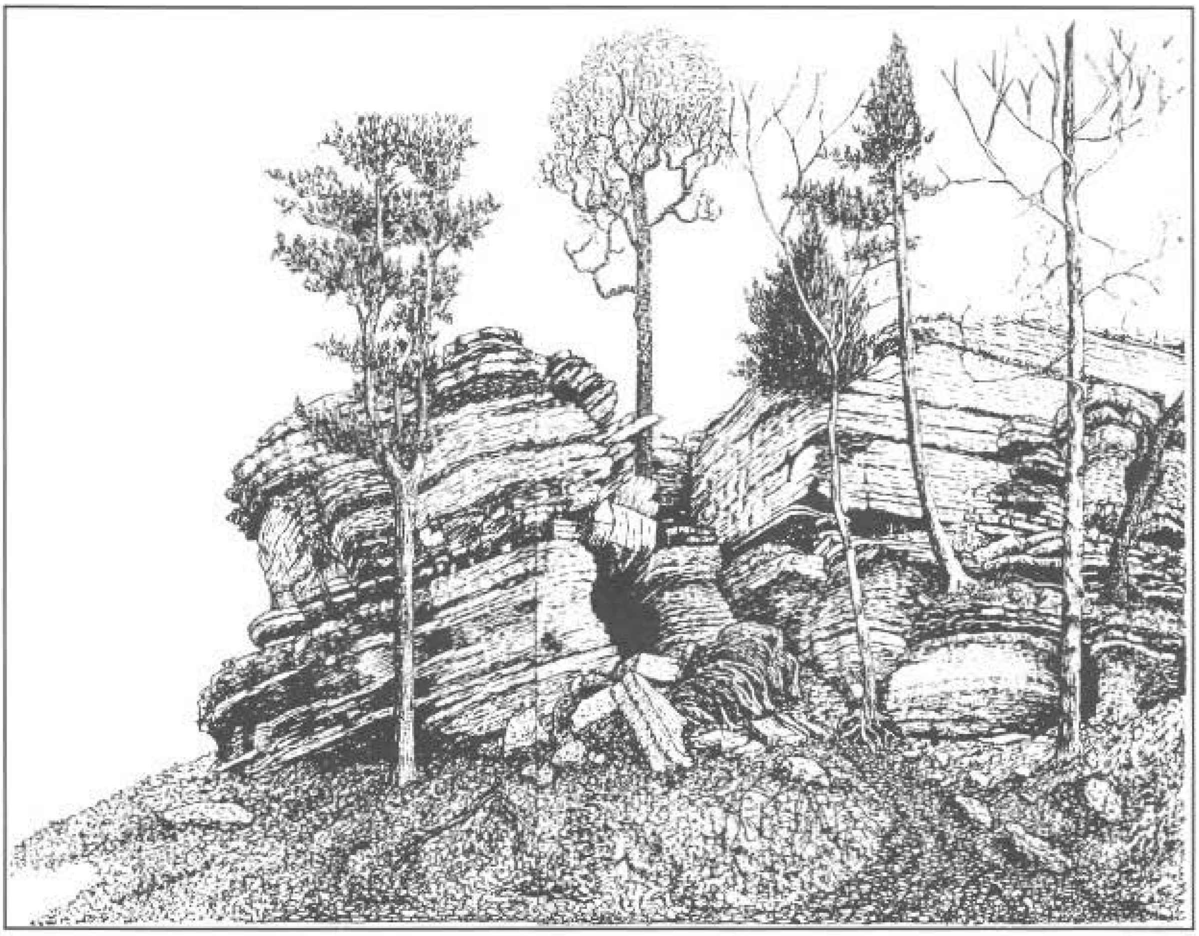


Figure 185

View of Devils Kitchen, showing subsidence blocks of Compton Limestone. The kitchen entrance is below the second tree from the left. Illustration by Dickson Stauffer.

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NOTE: The Missouri Department of Natural Resources, Division of Parks and Historic Preservation, has numerous park brochures, trail guides, and booklets that will be helpful in visiting and understanding geologic features in state parks. This information is available at state park visitor centers, or by writing or calling the central office, P.O. Box 176, Jefferson City, MO 65101; (314) 751-2479 or 1-800-334-6946.

Appendix

Use Of Topographic Maps For Location

Topographic maps, because of their rectangular shapes, are customarily referred to as *quadrangles* and are named for contained, prominent geographic features. For example, the Jefferson City Quadrangle contains that city and its surrounding area. Two quadrangles, Sedalia East and Sedalia West, cover the area of the city of Sedalia.

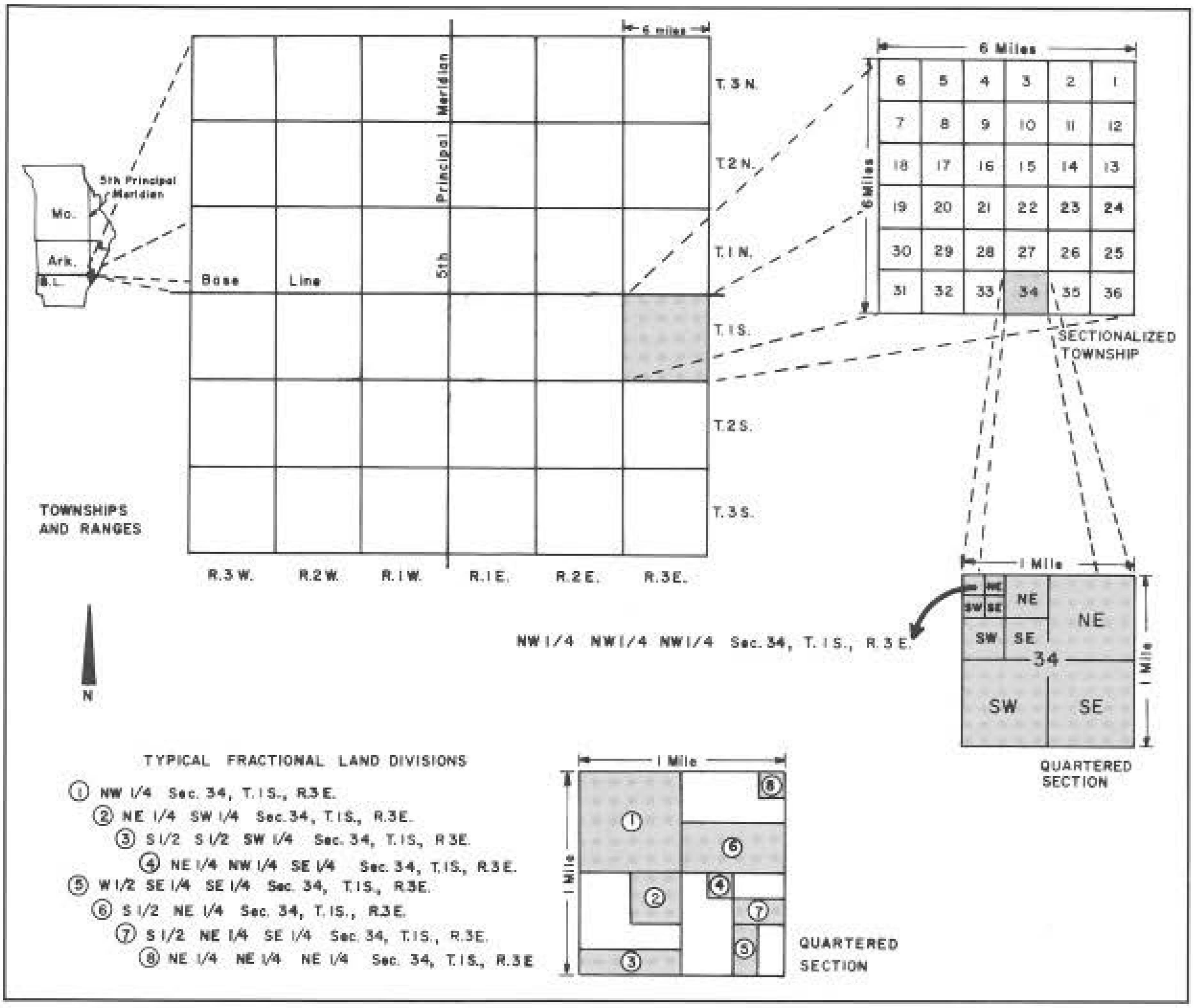
In several cases, two quadrangles have the same name but differ in having different scales and sizes of included areas. The Rolla 7½-minute Quadrangle contains one quarter of the area of the Rolla 15-minute Quadrangle but is on a scale approximately two and a half times as great (or as detailed) as the 15-minute quadrangle. These maps may be purchased from the Missouri Department of Natural Resources, Division of Geology and Land Survey, in Rolla.

Figure 186 shows the sizes and relationships of idealized townships, ranges, sections, and fractional sections. Government townships are designated by their positions relative to north-south lines of longitude called principal meridians and east-west latitude lines call baselines. For example, the abbreviation T. 1 S., R. 3 E., refers to a township lying in the first tier of townships south of a certain baseline and in the third township east of a principal meridian.

The fractional section system of locations shown in figure 186 is very convenient for designating locations in written and oral communications, but care must be taken that the proper township and range are read from the map. The abbreviated location of Area 7 in figure 186 is designated as the S½ NE¼ SE¼ sec. 34, T. 1 S., R. 3 E. The expanded version of this abbreviation reads as follows: the south half of the northeast quarter of the southeast quarter of section 34, Township 1 South, Range 3 East. Townships are coded along the east and west margins of the map; ranges along the north and south margins. In general, boundaries of topographic maps do not follow township and range boundaries.

As shown in figure 186, all Missouri townships extend northward from a parallel of latitude passing through central Arkansas and thus have a "north" designation. The Fifth Principal Meridian enters Missouri in southwestern Ripley County and leaves the state in eastern Pike County, therefore, all Missouri ranges are designated as "east" or "west" depending upon their position relative to this meridian.

An ideal government township is 6 miles long by 6 miles wide and contains 36 sections, each of which encompasses an area of 1 square mile or 640 acres. It should be emphasized that a government township does not necessarily have the same area and boundaries as a political township. Political townships can be of various sizes and are given proper names such as *Liberty Township* rather than numerical designations.



5th Principal Meridian
Mo.
Ark.
B.L.
Base Line
5th Principal Meridian
6 miles
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
T. 3 S.
R. 3 W.
R. 2 W.
R. 1 W.
R. 1 E.
R. 2 E.
R. 3 E.
TOWNSHIPS AND RANGES
N
6 Miles
6 Miles
6 5 4 3 2 1
7 8 9 10 11 12
18 17 16 15 14 13
19 20 21 22 23 24
30 29 28 27 26 25
31 32 33 34 35 36
SECTIONALIZED TOWNSHIP
1 Mile
1 Mile
NE SW SE NE SW SE NE 34 SW SE
NW 1/4 NW 1/4 NW 1/4 Sec. 34, T. 1 S., R. 3 E.
QUARTERED SECTION
TYPICAL FRACTIONAL LAND DIVISIONS
① NW 1/4 Sec. 34, T. 1 S., R. 3 E.
② NE 1/4 SW 1/4 Sec. 34, T. 1 S., R. 3 E.
③ S 1/2 S 1/2 SW 1/4 Sec. 34, T. 1 S., R 3 E.
④ NE 1/4 NW 1/4 SE 1/4 Sec. 34, T. 1 S., R. 3 E.
⑤ W 1/2 SE 1/4 SE 1/4 Sec. 34, T. 1 S., R. 3 E.
⑥ S 1/2 NE 1/4 Sec. 34, T. 1 S., R. 3 E.
⑦ S 1/2 NE 1/4 SE 1/4 Sec. 34, T. 1 S., R. 3 E.
⑧ NE 1/4 NE 1/4 NE 1/4 Sec. 34, T. 1 S., R. 3 E
1 Mile
1 Mile
① ② ③ ④ ⑤ ⑥ ⑦ ⑧
QUARTERED SECTION

Figure 186

The relationship of land divisions in quartered sections to townships and ranges is illustrated above. The numbered location descriptions (bottom left) correspond with the numbered and shaded areas in the quarter section (bottom right).

Glossary

Selected Geologic Terms Used In Text

Italicized terms within definitions are defined elsewhere in the GLOSSARY.

Amphiboles and Pyroxenes — These *minerals* are generally darker in color than the *feldspars* and occur in *igneous* rocks. Their composition is complex but the most common constituents are magnesium, iron, calcium, and silica. They are most obvious in the coarse-grained igneous rocks such as *granite, pegmatite,* and *diabase.*

Calcite — A mineral composed of calcium carbonate ($CaCO_3$); the major mineral constituent of *limestone.* It is one of the softest of the easily recognized minerals common in Missouri and will effervesce or "fizz" freely when a drop of diluted muriatic (hydrochloric) acid is placed on it. Calcite is very easily broken and breaks or cleaves along both parallel and intersecting planes. The intersecting planes are at such an angle that fragments of calcite formed by cleavage are rhombohedral in shape. In southwestern Missouri calcite is colloquially called "tiff," a name which is somewhat confusing because "tiff" is the colloquial term for barite in areas where this mineral is mined.

Chert — A rock containing a very fine aggregate of *quartz* and other silica minerals such as chalcedony and opal. It is also known as flint and the distinction between flint and chert is a fruitful topic for argument. Many geologists consider flint to be a colloquial name for chert; others would state that flint is a dark variety of chert — a classification followed by archaeologists.

Chert is harder than glass and easily scratches steel. It differs from quartz in being noncrystalline and in general is opaque. Because it is exceptionally fine grained it tends to break with conchoidal fracture — that is with a surface containing shell-like humps and hollows, although fragments of chert may contain very sharp corners and edges. It can be a variety of colors but the most common colors in Missouri are white, gray, and dark hues ranging to a blue-black. Some of the weathered cherts are stained brown by iron oxides.

Conglomerate — A gravel cemented by materials such as silica or iron oxides to form a rock.

Diabase — A dark, fairly fine-grained *igneous* rock occurring as *dikes* or veins in the igneous rock area of southeastern Missouri. The component minerals are not easily identified with the naked eye and the rock is generally recognized by its black to dark green color and somewhat granular appearance. In outcrop area it is subordinate to the *felsites* and *granites* of Missouri.

Dike — A wall-like mass of *igneous* rock intruded into older rock, often along fractures.

Dip — The angle of slope, measured from the horizontal, of rock strata (as applied to sedimentary rocks).

Dolomite — A *rock* name which is also a *mineral* name, e.g., the rock dolomite is made up of an aggregate of particles of the mineral dolomite. Chemically the mineral dolomite is a calcium-magnesium bicarbonate $CaMg\ (CO_3)_2$ and thus differs from limestone in having magnesium added to the chemical formula. Dolomite contrasts with limestone in effervescing or "fizzing" less vigorously when tested with hydrochloric acid. Many laymen do not distinguish between limestone and dolomite, and the dolomites which are especially widespread in the Ozark area are often colloquially referred to as "limerock." Dolomite and *limestone* are very close relatives and the percentage of magnesium may determine whether a given rock is a limestone, a dolomitic limestone, a calcareous dolomite, or a true dolomite. Both limestone and dolomite are especially vulnerable to the dissolving action of moving waters and are the two rocks in which caves, sinkholes, and large springs of Missouri are most commonly found (*karst* topography).

Drift — A general term applied to all sedimentary deposits resulting from glacial activity.

Fault — A *fracture* in the earth's crust along which displacement occurred.

Feldspars — Light-colored aluminum silicates with varying amounts of potassium, calcium, and sodium. Exact identification of the numerous types of feldspar minerals often requires microscopic examination. The feldspars are harder than glass but slightly softer than *quartz*. They are important components of many of the *igneous* rocks such as *granite, pegmatite,* and *felsites*, and most of them in Missouri originated under high temperature conditions.

Felsite — A general term for light-colored fine-grained igneous rocks. A *rhyolite* is one of the the many felsites.

Fractures — A fracture is the general term for a break in the earth's crust. Two special types of fractures are *faults* and *joints.*

Granite — An *igneous* (once molten) rock composed of the minerals quartz, mica, and to a minor extent, *pyroxenes* and *amphiboles.* Mineral crystals are visible to the naked eye. Missouri granites are pink because of the predominance of *feldspars* of that color.

Hematite, Limonite, and Magnetite — Hematite is an iron oxide (Fe_2O_3) whereas limonite is a family of iron oxides combined with water ($Fe_2O_3nH_2O$). Both have a long history as important sources of iron ore in Missouri and although they are not major rock components percentage-wise, they are responsible for much of the rock and soil coloration in the state. A red to brown soil or a red, brown, purple, or orange sedimentary rock in the Ozarks of Missouri strongly suggests that one or both of these minerals is present in sufficient form to color the soil or rock. Magnetite (Fe_3O_4) is the iron oxide which is attracted by a magnet. Although hematite is red when finely ground, in the lump form it may vary in appearance from red to steel-gray or black. Limonite may vary from brown to black in the lump form and one variety is yellow. In addition to being sources of iron, both minerals also have use as coloring agents, a quality which was recognized by Indians who used them for war paint.

Some of the iron ores were formed under fairly normal temperature conditions, but the hematite and magnetite mined at Pea Ridge, Iron Mountain, and Pilot Knob apparently originated under high temperature conditions.

Igneous (rock) — A rock which was once molten (e.g. *granite, rhyolite, felsite, porphyry).*

Joints — *Fractures* in the crust of the earth along which there has been little or no movement. They tend to be geometrically oriented relative to one another so that it is not uncommon to find a number of these breaks as a set of vertical or nearly vertical parallel planes. In a given exposure more than one set of joints may be visible. For example parallel joints or breaks may trend a given direction such as northwest and a number of parallel joints may trend another direction such as northeast. Should the sets of parallel joints intersect one another at right angles and be vertical the tendency would be to break the rock into many prisms. Joints have a great role in the location and pattern of caves, sinkholes, and spring systems as well as in determining stream courses.

Karst — See text, page 153.

Limestone — An aggregate of crystals of *calcite;* in some limestones the individual calcite fragments are so large that they are visible with the naked eye. The great majority of the Missouri limestones were deposited in seas which once covered the area and as a result contain many fossils. Some of the Missouri limestones which are durable and attractive when polished are the sources of commercial marble. Although some geology textbooks define marble as a metamorphosed limestone this restrictive definition is not accurate as used in the trade and none of the Missouri marbles is a metamorphosed limestone. Also, see *Dolomite.*

Limonite — (see *Hematite)*

Loess — A clayey silt deposited by wind action during times between and after glaciations. Characteristically it is light brown and tends to stand as vertical bluffs, so that vertical roadcuts may be made in it without the necessity of grading backslopes. Because it was deposited by the wind it may have the shape of dunes or a form similar to gigantic snow drifts. Such topography is especially pronounced on the east side of the Missouri River in northwestern Missouri where prevailing westerly winds picked silt off the floodplain and redeposited it in giant drifts on the east side of the river.

Magnetite — (see *Hematite*)

Mica — The mica *minerals* are complex potassium aluminum silicates and have the property of crystallizing as laminated sheets. Isinglass is one of the more common forms of mica and the insulation material vermiculite is a type of mica (not from Missouri) which will expand greatly when heated. Sheets of mica are commonly used in electrical components and for insulation. The major occurrences of mica in Missouri are in some *sandstones*, certain *clays* and *shales*, and the *igneous* or once molten rocks, such as *granite*.

Mineral — There is no perfect definition, but one of the more common states that a mineral is a naturally occurring inorganic compound with definite physical and chemical characteristics. This is not completely accurate because some minerals are composed of organic substances and some have variable physical and chemical properties.

Pegmatite — Pegmatites are in many cases very similar in composition to *granites* but are characterized by being exceedingly coarse grained — so coarse grained that the size of individual mineral crystals may be measured in inches or feet. The most famous outcrop of pegmatite in Missouri is at Decaturville (No. 389, page 328).

Porphyry — *An igneous rock* containing *mineral* crystals of contrasting size or visible crystals surrounded by material without crystals visible to the naked eye.

Pyrite and Marcasite — Although pyrite and marcasite are not major rock constituents in Missouri they are so common, especially in some of the *shales*, and are such a source of interest that they merit mention. In chemical composition both are composed of iron sulfide (FeS_2) but they differ from one another in their crystal structure and to some extent in color. Typically pyrite is a brassy yellow and a common crystal form is that of a cube or a twelve-sided crystal whose shape has been copied in a popular desk calendar. Marcasite tends to be less yellow than pyrite but the color distinction isn't always obvious. Marcasite crystals belong to a different family than those of pyrite thus they are never cubical. Pyrite, which is best known as "fool's gold" but is much harder and unfortunately more common than gold, was mined in Missouri in the past as a source of sulfuric acid. Both pyrite and marcasite are common in *shales*, especially those associated with coal, and are also present in some other rock types throughout the state.

Pyroxene — (See *Amphibole*)

Quartz — A very common *rock*-forming *mineral* characterized by generally having a glassy appearance and being harder than glass or steel. If it is in a crystalline form, six-sided crystals are common. Color is not necessarily diagnostic because it may vary from clear to black with a variety of hues such as pink, red, and amethyst (purple). It is composed of silicon dioxide (SiO_2).

Although quartz superficially resembles *calcite* and some forms of barite ("tiff") in being glassy it is not reacted on by most acids as is calcite; it is much lighter in weight than barite, and much harder than calcite or barite.

Quartz may be formed under either normal or high temperature conditions and thus is a very common mineral. Because it is a major constituent of most Missouri sandstones and a predominant component of *chert* (flint) it is one of our most important minerals, even though it may have little local economic value as a mineral per se. Very pure sandstones composed of grains of quartz are quarried for "silica sand" at Pacific, Crystal City, and other areas in eastern Missouri.

The so-called "mineral blossom" (fig. 187) is a form of low temperature quartz occurring as a coating of very small crystals lining cavities or on the surface of chert. This attractive mineral, common in Washington and surrounding counties, is also called quartz druse or drusy quartz and was called "mineral blossom" by the early miners because it is common in the areas of near-surface lead and barite deposits. It is not a statewide reliable guide to these minerals because it is absent in many areas of lead and barite production and present in other areas where these mineral commodities are apparently absent.

Residuum — Rock remnants and decay (*weathering*) products remaining after more soluble constituents have been naturally removed.

Chert is a common rock contained within the *limestones* and *dolomites* of the Ozarks and surrounding areas. Limestones and dolomites are among the first rocks to be dissolved by weathering, and chert may be left behind as a residual material when limestones and dolomites have been dissolved

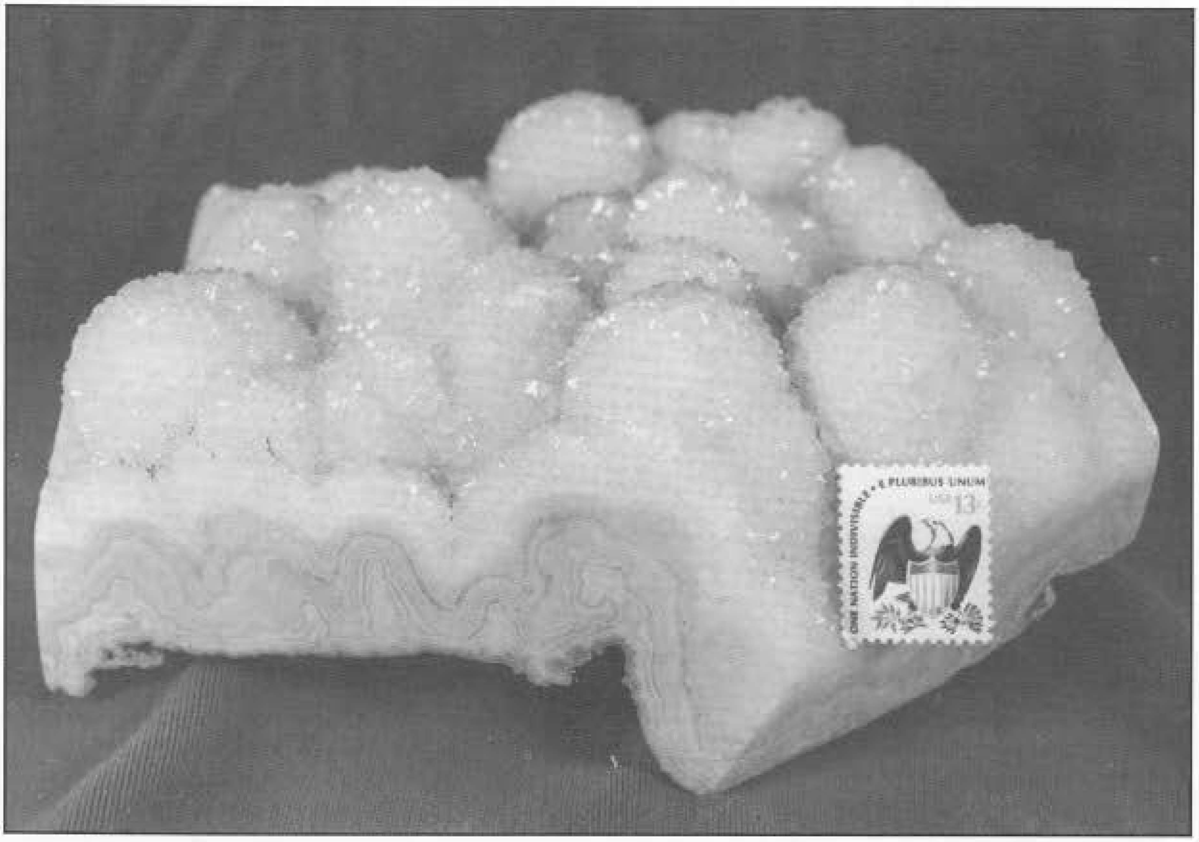


Figure 187

"Mineral blossom" quartz. Photo by Jerry D. Vineyard.

away. Some of the deep cuts in the Ozarks, especially in the southeastern part, show residuum of chert mixed with red or brown clay as thick as a hundred or more feet.

Rhyolite — A fine-grained light-colored *igneous* rock (*felsite*) with evidence of flow (a lava). Some of Missouri's so-called rhyolites are fused volcanic ash and not flows.

Rock — An aggregate of one or more *minerals*. This definition, like that of mineral, is not completely accurate but should suffice for the present discussion. A good example of a rock is a very pure sandstone such as the St. Peter which is quarried in east-central Missouri. This rock (*sandstone*) is composed almost entirely of one mineral (*quartz*) and thus is an aggregate of quartz grains. Because it is an exceptionally pure sandstone the other mineral components represent less than 1 percent of its composition. An example of a rock containing many minerals is *granite*, which is composed of the minerals *quartz*, *feldspar*, *amphiboles*, *pyroxenes*, and *micas*.

Sand and Sandstone — Sand consists of grains of from 1/16 millimeter to less than two millimeters in size. The predominant constituent of Missouri sandstones is *quartz* but there may also be *mica* or *feldspar* in some of the sands, especially those of western Missouri, and those formed by erosion of the *igneous* rock in southeastern Missouri. Sands from the Missouri River contain lignite at many localities because they are derived in part from the disintegration of rocks in coal-bearing areas in the upper reaches of the Missouri. If a sand is naturally cemented together it is a sandstone.

Shale and Clay — Clay is rock made up of clay minerals less than 1/256 millimeter in diameter. If clay minerals are cemented together and tend to have a very fine stratification or lamination the resulting material is a shale; if no laminations are visible, the material is a claystone. Some shales in addition to containing the clay minerals and organic material may contain very fine grains of *mica*.

Shut-in — See page 39.

Sink or Sinkhole — See page 153.

Till — Predominantly unstratified, unsorted, generally unconsolidated glacial *drift* consisting of a great variety of materials such as clay, silt, sand, gravel, and boulders. It is deposited directly by glaciers and its contents are mixed in varying portions. It is the major glacial deposit in the Midwest and has been aptly described as "geologic garbage" because of its heterogeneous composition.

Weathering — The process which involves the chemical corrosive action of air, rainwater, plants, and bacteria and the mechanical disintegration of rock resulting from temperature changes such as freezing and thawing which cause rocks to crumble and decay. If a rock is exposed to the action of the atmosphere, water, and bacteria, individual particles will eventually disintegrate and the rock will be reduced in size as fragments break away or are dissolved. The dissolving action of water charged with carbon dioxide from the air is an important factor in weathering, especially of *limestones* and *dolomites*. Freeze and thaw activities will also cause rocks to spall and breakdown as will changes in the chemical composition of rocks on exposure to the weather. Even plants play a role in the breaking down of rocks as demonstrated by the action of the roots which tend to force rocks apart and by the action of humic and tannic acid formed by the decay of plants.

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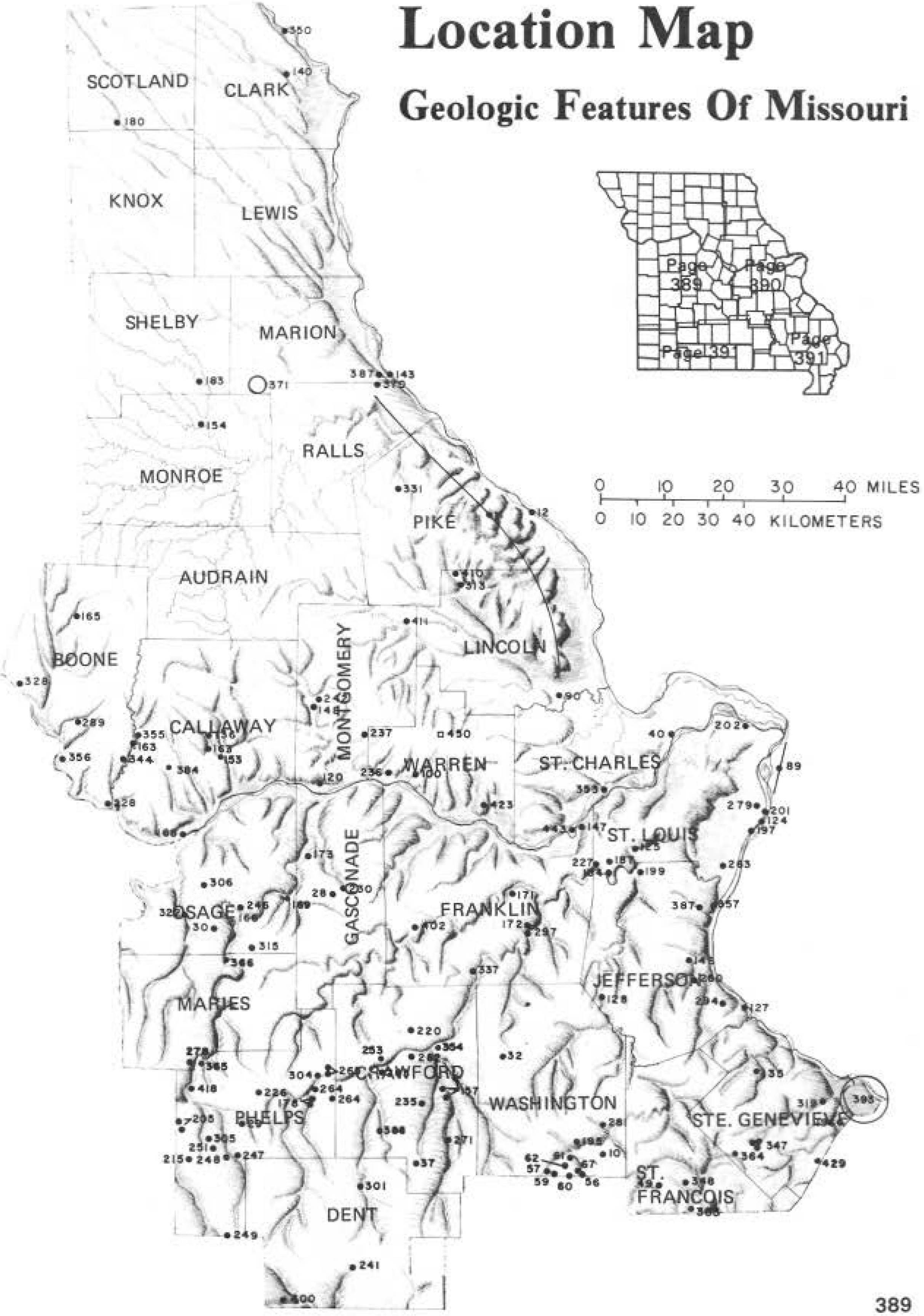
417. Devils Backbone (Perry County)
418. Devils Backbone (Phelps County)
419. Devils Backbone (Ripley County)
420. Devils Backbone (Shannon County, sec. 5)
421. Devils Backbone (Shannon County, secs. 35 and 36)
422. Devils Backbone (Texas County)
423. Devils Boot
424. Devils Cave
425. Devils Chute
426. Devils Den (Howell County)
427. Devils Den (Stone County)
428. Devils Den Hollow (Iron County)
429. Devils Den Hollow (Ste. Genevieve County)
430. Devils Den Hollow (Stone County)
431. Devils Elbow (Butler County)
432. Devils Hole (Barry County)
433. Devils Hole (Laclede County)
434. Devils Hole Cave (Shannon County)

435. Devils Hollow (Bates County)
436. Devils Hollow (Texas County)
437. Devils Horn (Carter County)
438. Devils Horn (Worth County)
439. Devils Icebox (Iron County)
440. Devils Kitchen (Barry County)
441. Devils Kitchen (Carter County)
442. Devils Pool
443. Devils Raceground
444. Devils Racetrack
445. Devils Ridge
446. Devils Rockpile
447. Devils Run (Carter County, secs. 3 and 4)
448. Devils Run (Carter County, secs. 7 and 8)
449. Devils Tea Table (Cape Girardeau County)
450. Devils Washbasin
451. Devils Washboard (Dunklin County)
452. Devils Washboard (Wayne County)
453. Red Devil Ditch
454. Devils Tea Table (Pulaski County)
455. Devils Elbow (Pulaski County)
456. Devils Sugar Bowl
457. Devils Kitchen

Location Map

Geologic Features Of Missouri



SCOTLAND
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MARION
RALLS
MONROE
PIKE
AUDRAIN
LINCOLN
BOONE
CALLAWAY
MONTGOMERY
WARREN
ST. CHARLES
ST. LOUIS
OSAGE
GASCONADE
FRANKLIN
MARIES
JEFFERSON
CRAWFORD
WASHINGTON
PHELPS
STE. GENEVIEVE
ST. FRANCOIS
DENT
Page 389
Page 390
Page 391
Page 391
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0 10 20 30 40 KILOMETERS
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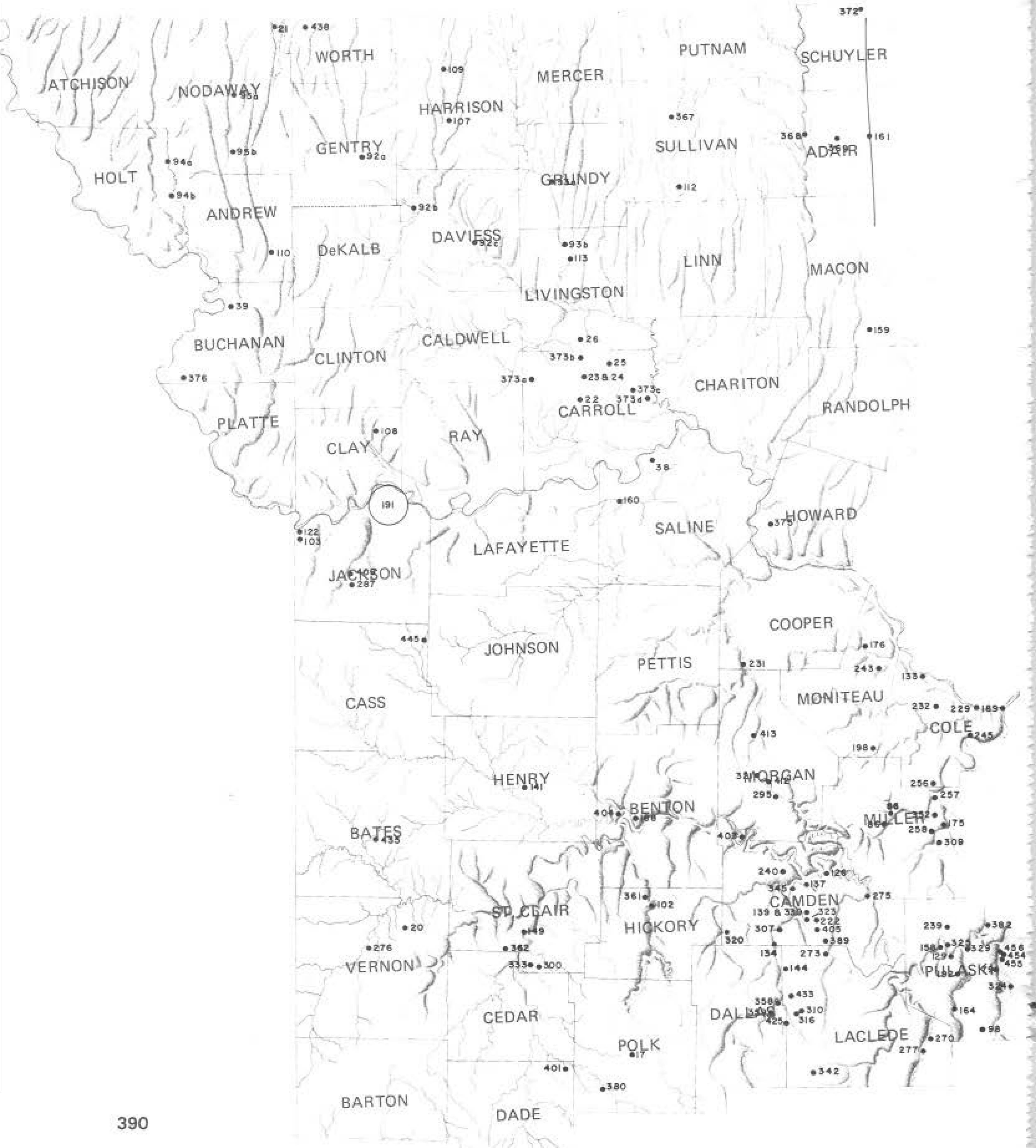
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ADAIR
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GENTRY
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SULLIVAN
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GRUNDY
112
ANDREW
92b
DAVIESS
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MACON
LIVINGSTON
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BUCHANAN
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CALDWELL
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373b
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23 & 24
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CARROLL
RANDOLPH
PLATTE
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CLAY
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HOWARD
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SALINE
LAFAYETTE
JACKSON
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COOPER
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JOHNSON
PETTIS
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MONITEAU
CASS
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COLE
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MORGAN
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HENRY
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BENTON
MILLER
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CAMDEN
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139 & 330
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ST. CLAIR
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HICKORY
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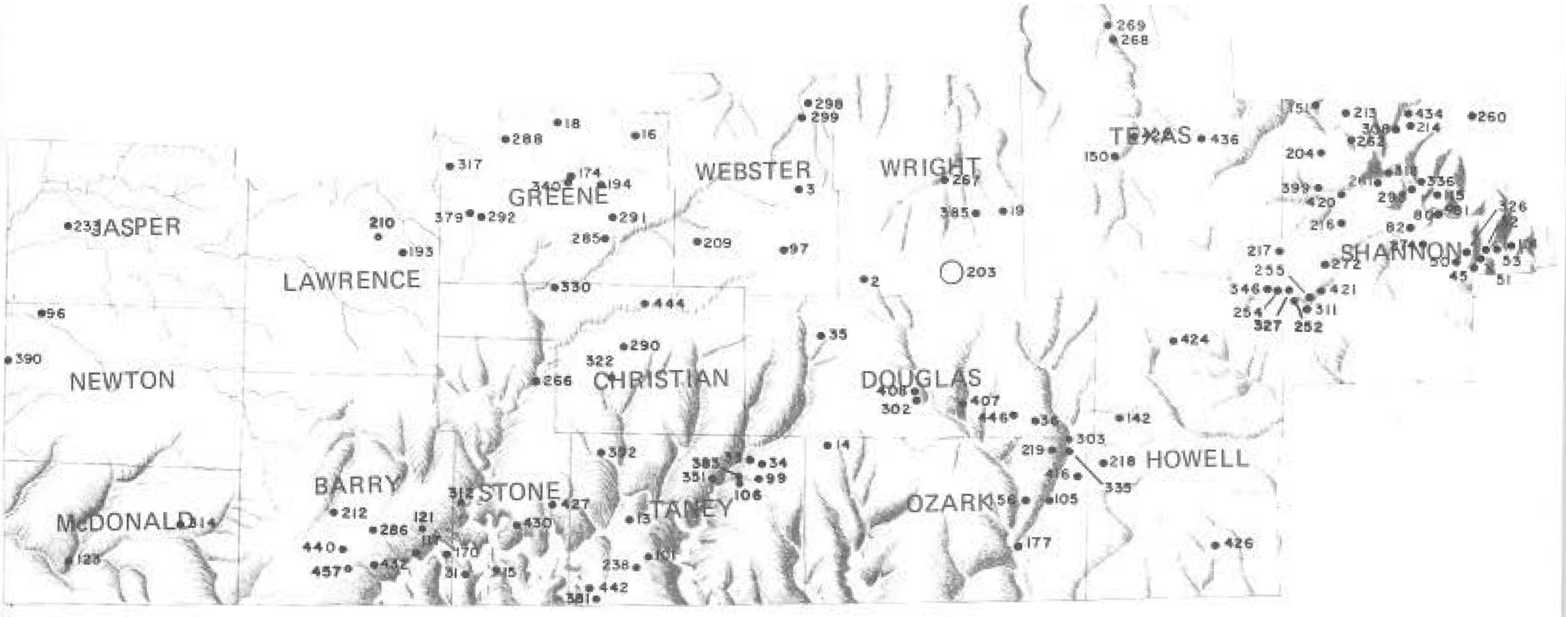
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WRIGHT
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SHANNON
NEWTON
CHRISTIAN
DOUGLAS
HOWELL
BARRY
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TANEY
OZARK
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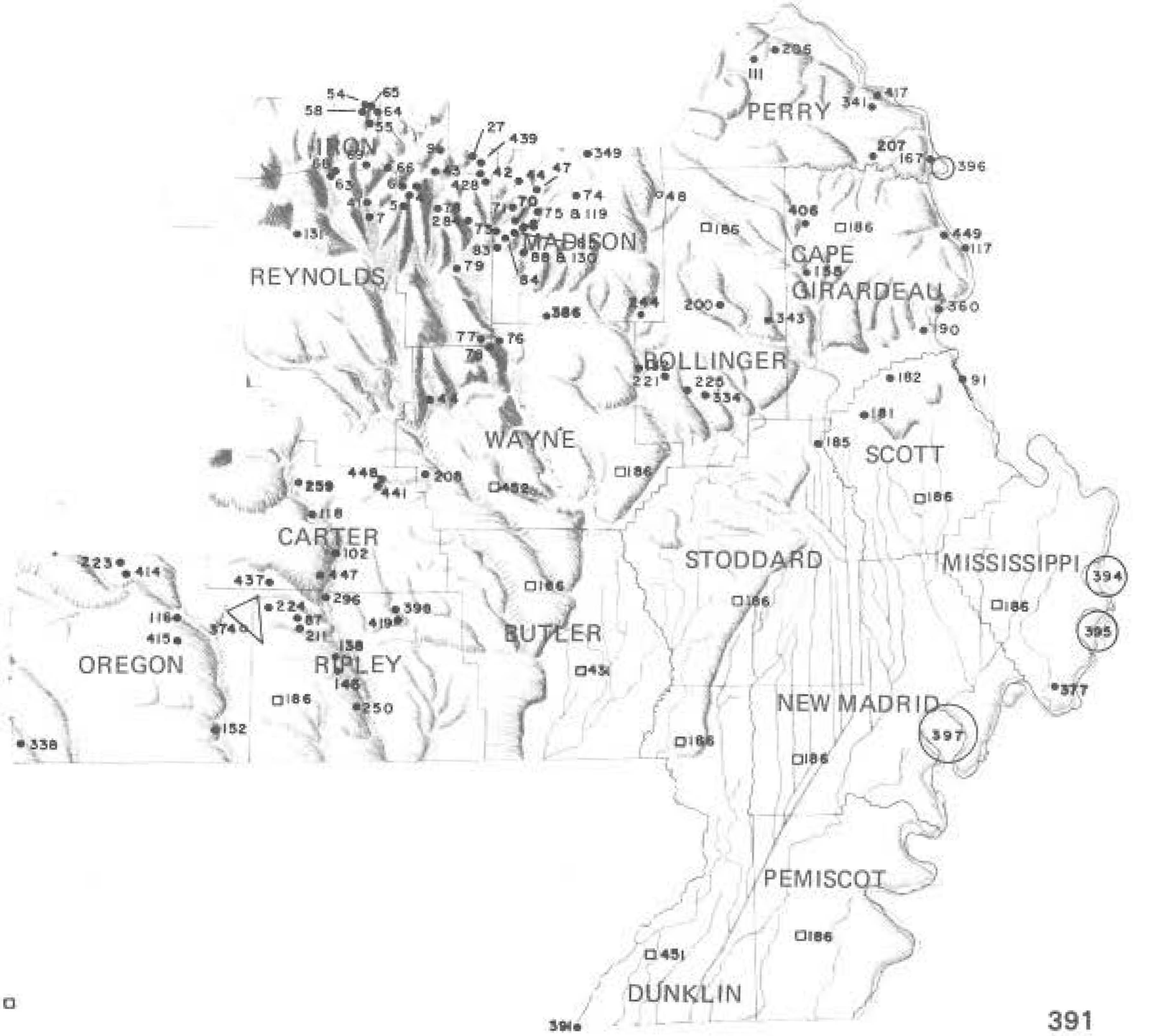
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RIPLEY
BUTLER
NEW MADRID
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MISSOURI DEPARTMENT OF NATURAL RESOURCES' DIVISION OF GEOLOGY AND LAND SURVEY

On February 24, 1853, the Missouri Legislature created the first state agency commissioned to study the natural resources of Missouri — the Geological Survey of Missouri. George Clinton Swallow was appointed state geologist and became the first director of the agency.

At the beginning of the Civil War, the survey was discontinued. It was reinstated in 1870 as the Missouri Bureau of Geology and Mines but became inactive in 1878 after the resignation of state geologist, Charles Williams. The survey was reestablished May 18, 1889, and, as the third geological survey of Missouri, became the direct predecessor of today's Division of Geology and Land Survey.

In 1933, the survey was renamed the Missouri Geological Survey and Water Resources. With state reorganization in 1974, the Geological Survey, along with the Land Survey Authority, created in 1970, were placed together in the Department of Natural Resources to form the department's Division of Geology and Land Survey. Later, in 1981, legislation created the Dam Safety Program and placed it in the same division. The Water Resources Program was added in 1987.

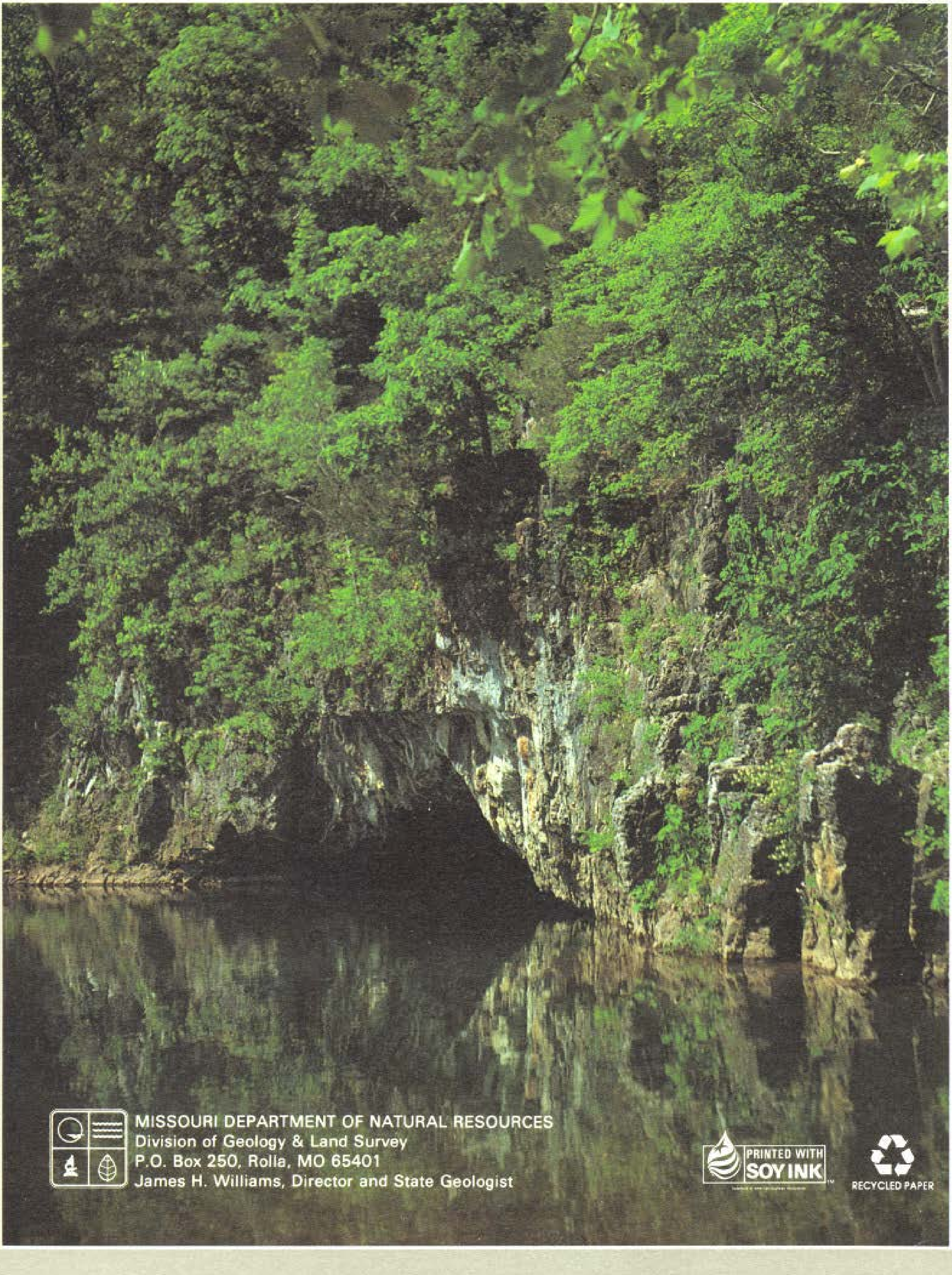
The survey has had its headquarters in Rolla since 1901, and has been located in the Buehler Building on Fairgrounds Road since 1963. In 1984 an adjacent building on Gale Drive was modified for the Land Survey Program; and in 1989 a building was purchased on Research Drive in Dietzmann Industrial Park to house the McCracken Core Library.

On October 13, 1989, the Division of Geology and Land Survey celebrated 100 years of continuous service to the people of Missouri, and also dedicated the McCracken Core Library.

The Division of Geology and Land Survey has an experienced staff of geologists, land surveyors, engineers, planners, soil scientists, hydrologists, technicians, and support personnel. The division's five programs include Administration, Geological Survey, Water Resources, Land Survey, and Dam and Reservoir Safety.

Visitors are welcome at Division headquarters on Fairgrounds Road in Rolla, and guided tours can be arranged. Call 314-368-2100 or write P.O. Box 250, Rolla, MO 65401.

Swallow 1855



MISSOURI DEPARTMENT OF NATURAL RESOURCES
Division of Geology & Land Survey
P.O. Box 250, Rolla, MO 65401
James H. Williams, Director and State Geologist

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